



L E A R N

GEF IW:LEARN

Considering Climate
Variability and
Change
Impacts in
GEF IW Marine
Project Implementation



Empowered lives.
Resilient nations.



Contents

Welcome 3

1. Introduction 4

1.1 Objectives of this Guidance 4

1.2 Sources of Information 7

1.3 Making Use of Published Climate Change Guidance 8

2. Addressing climate change 9

2.1 Incorporating Climate Change Issues Within IW Marine Projects 10

2.2 Checklists on Climate Change Issues for IW Marine Project Implementation 21

 2.2.1 Inception Phase 22

 2.2.2 Implementation Phase 25

 2.2.3 Project Closure 28

2.3 Specific Climate Change Issues Related to Marine Ecosystem Type 28

3. References 37



Welcome

GEF Flickr

This GEF IW:LEARN guidance document is designed to assist GEF IW marine projects with meeting the GEF-5 requirement to consider climate change and variability impacts during project implementation.

These materials have been gathered to help explain the need for mainstreaming climate concerns in IW and to assist projects in locating practical information. This guidance is NOT intended to serve as an exact instruction. Projects should utilize national and regional expert consultation for specific recommendations.

This guidance presents the types of discussion and research pertaining to climate variability and change that should be undertaken at the inception and implementation phases and closure of a GEF IW marine project. It offers some practical examples from the IW Portfolio on including climate considerations in project activities to supplement the extensive list of approaches delineated in the References section.

This guidance is relevant to marine (Large Marine Ecosystem, open ocean and coastal zone) projects—a companion guidance for freshwater (rivers, lakes, groundwaters and wetlands) projects is also available. Both documents follow a similar form.

Because the subject area is in constant flux and new examples of good IW Portfolio practices will become available, GEF IW:LEARN welcomes any feedback and suggested successful (and unsuccessful) approaches for inclusion in a future update.

<https://iwlearn.net/manuals/methodologies>



1. Introduction

1.1 Objectives of this Guidance

Climate change is now an inescapable reality. Human activity is leading to ever increasing levels of greenhouse gas (GHG) emissions and steadily compromising the natural resources needed to maintain the health of the planet. Without a secure natural environment, human development cannot be sustained. If not adequately addressed, the climate change crisis could potentially reverse development gains already made and block achievement of the upcoming [Sustainable Development Goals \(SDGs\)](#), which build upon the [Millennium Development Goals \(MDGs\)](#). Climate change has been recognized as a significant driver (or root cause) of a number of transboundary problems in international waters, including invasive species, water quantity, changes in biodiversity, loss of ecosystems and eutrophication.

As the name implies, this is a "guidance" for GEF IW projects, not a didactic instruction manual. It provides examples of how a number of IW marine projects have approached climate change and variability, and presents options through selected reference materials from academia and a range of organizations.

GEF 5 identified additional climate change and variability priorities that require adequate mainstreaming within all IW projects. This guidance responds to IW project need for information on:

- The main topics relating to climate variability and change for consideration at the key stages of project execution (inception, implementation and closure);
- Specific tools that GEF IW projects should be focusing on to "mainstream" climate issues within their activities. This includes (environmental) monitoring and evaluation (M&E), TDA/SAP design and use of climate change and impacts scenarios;
- The main climate issues likely to affect specific marine ecosystem types (LME, open ocean, coastal zone);
- The main sources of information pertaining to climate change (a "guide to the guides"), recognizing that there is a multiplicity of policy and technical guidance available.

This guidance links closely with issues highlighted within the [TDA/SAP Manual](#) and [Project Management Manual](#). References and links are made to these documents where appropriate.

Some Definitions of Mainstreaming Climate Change

The most widely used and referenced definition of "mainstreaming" is from Klein, R. et al, Tyndall Centre: "Mainstreaming involves the integration of policies and measures that address climate change into development planning and ongoing sectoral decision-making, so as to ensure the long-term sustainability of investments as well as to reduce the sensitivity of development activities to both today's and tomorrow's climate... Mainstreaming entails making more efficient and effective use of financial and human resources rather than designing, implementing and managing climate policy separately from ongoing activities. (See [57](#)).

The UNDP–UNEP Poverty–Environment Initiative (PEI) has defined mainstreaming climate change adaptation as "...the iterative process of integrating considerations of climate change adaptation into policymaking, budgeting, implementation and monitoring processes at national, sector and sub-national levels. It is a multi-year, multi-stakeholder effort grounded in the contribution of climate change adaptation to human well-being, pro-poor economic growth, and achievement of the MDGs. It entails working with a range of government and non-governmental actors, and other actors in the development field." (See [55](#)).

The Institute of Development Studies (IDS) states that "...mainstreaming implies that awareness of climate impacts and associated measures to address these impacts, are integrated into the existing and future policies and plans of developing countries, as well as multilateral institutions, donor agencies and NGOs." (See [46](#)).

Lebel, L. et al. from Adaptation Knowledge Platform and SEI say that "...mainstreaming' entails the integration of adaptation to climate change into development planning...can also be a form of cross-sectoral policy integration" (See [49](#)).

Some organizations introduce the element of risk in the concept of mainstreaming. SPREP, UNDP and GEF state "climate change mainstreaming is about integrating climate risks into development planning processes and decision-making. This means incorporating climate risk considerations into every aspect of the policy and project development process" (see [52](#)), while CARE states that "Mainstreaming climate change adaptation describes a process of considering climate risks to development projects, and of adjusting project activities and approaches to address these risks...can therefore ensure that development programs and policies are not at odds with climate risks both now and in the future." (See [47](#)).

One government definition (Prime Minister of Finland Office) stresses the importance of the climate policy, namely, "The mainstreaming of climate policy, i.e. the process by which climate policy is rooted and implemented more systematically than before in the various fields of administration and policy may be of assistance in a major challenge for change." (See [56](#)).

UNDP and USAID give the most straightforward definition of mainstreaming. It is "... the integration of climate concerns and adaptation responses into relevant policies, plans, programs, and projects at the national, sub-national, and local scales." (See [58](#) and [36](#)).

Practical "How To" Guidance for Integrating Climate Change Adaptation into Development Projects

The document includes simple checklists to ensure that development activities do not increase people's vulnerability to climate change. It provides guidance and recommends tools for all stages of the project cycle, as well as tools, resources and practical examples from CARE projects around the world. Water resource management and agriculture projects are specifically highlighted, as they were targeted in the early tests of the Toolkit. This interactive Toolkit is designed to be flexible. Users can tailor the process to meet their needs, priorities and available resources. The Toolkit is designed to facilitate the integration of climate change adaptation into development projects. It is organized around the following simplified stages in the project cycle: analysis, design and implementation. Information and knowledge management, including monitoring and evaluation, is treated as an ongoing function, which is integrated into each of these stages. For each stage in the project cycle, key issues are identified and step-by-step guidance is provided, as are recommended support tools and resources. Case studies and examples from field-testing the Toolkit on CARE projects in Africa, Asia and Latin America demonstrate how it can be used in practice.

CARE: Toolkit for Integrating Climate Change Adaptation into Development Projects. (See [32](#)).

A Guidebook for Development Planners on Adaptation to Climate Variability and Change

The document presents the six step approach for assessing vulnerability and identifying and implementing climate change adaptations (V&A approach), which follows a developmental path parallel to the more general project cycle. STEP 1 is to screen for vulnerability that involves screening a current or proposed project design to determine if it might be affected by climate variability or climate change. STEP 2 is to identify adaptation options for modifying the project in response to vulnerabilities identified by step 1. STEP 3 is to conduct analysis, implementing partners, stakeholders and experts to evaluate each of the adaptation options. The purpose of STEP 4 is to use the results from Step 3 to select one or more adaptations to be implemented with assistance from the project or program. STEP 5 is to implement adaptations and STEP 6 is to evaluate adaptations.

USAID: Adapting to Climate Variability and Change: A Guidance Manual for Development Planners, 2007. (See [35](#)).

1.2 Sources of Information

A significant number of guidance documents and reports and scientific literature on climate variability and change are available in the public domain to aid GEF IW projects to understand key issues and provide guidance for implementation. However, the range of available materials can in itself be problematic. This “guide to the guidance” is intended to help IW projects focus on the most appropriate documents and case studies.

IW projects should recognize that there are likely significant national and regional resources available to assist in making projects robust with regards to climate variability and change. These resources include expertise and data involved in preparing national reports and communications to the United Nations Framework Convention on Climate Change (UNFCCC).

There are many definitions and explanations of the terms used within climate variability and change studies. For example, the World Bank has provided a summary of definitions [here](#).

An Example of National Resource for Mainstreaming: Canada

The document provides general guidance to be considered at the discretion of jurisdictions and regulatory authorities. It includes methods that can be used to obtain and evaluate information concerning a project's GHG emissions and the impacts of climate change on a project; key sources of information that practitioners can use to address climate change considerations in project Executing Agency (EA); and methodology to encourage the consistent consideration of climate change in the EA process across federal, provincial and territorial jurisdictions and public government institutions responsible for EA.

Canadian Environmental Assessment Agency: Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners. (See [43](#)).



1.3 Making Use of Published Climate Change Guidance

There is a multiplicity of guidance for IW marine projects available from international bodies, regional organizations, national authorities, regional (sub-national) commissions, academic and scientific institutions etc. [Part Three](#) of this guidance will provide a “guide to the guides” and, where relevant, these are linked to the information in Part One and Two.

Linkages are made to available guidance ([Part Three](#)) to further assist IW marine projects identify potential relevant assistance and experiences. Linkages are also made to other IW:LEARN manuals (specifically the TDA/SAP and the Project Management Manuals).

References are classified under the following categories:

- Web portals
- Policy guidance
- Practical guidance and tools
- Adaptation methodology
- Training/capacity building on climate change and adaptation
- Public/stakeholder involvement
- Water type information on:
 - Coastal zones/areas (geomorphologic area either side of the seashore in which the interaction between the marine and land parts occurs in the form of complex ecological and resource systems made up of biotic and abiotic components coexisting and interacting with human communities and relevant socio-economic activities);
 - Large Marine Ecosystems (relatively large areas of ocean space of approximately 200,000 km² or greater, adjacent to the continents in coastal waters where primary productivity is generally higher than in open ocean areas);
 - Open oceans (areas away from the coastal boundaries and above the seabed, encompassing the entire water column of the seas and the oceans, laying beyond the edge of the continental shelf).

Where available, GEF IW project experiences are included within the references/bibliography in [Part Three](#).



2. Addressing climate change

Overview

This section:

- Identifies issues on climate variability and change that IW marine projects should consider at different stages of implementation;
- Suggests principles that can be utilized for IW marine projects that are consistent with the with the ICZM and LME management concepts;
- Presents potential climate issues relevant to different marine ecosystem types (coastal zones, LMEs, open oceans);
- Provides guidance to ensure climate variability and change are integrated within IW marine project M&E and management;
- Presents the multiplicity of tools, guidance and examples available within the international community to address climate variability and change in marine ecosystems management.

2.1 Incorporating Climate Change Issues Within IW Marine Projects

Climate change issues should be reflected within a number of areas of an IW Marine Project, including:

- Guiding principles for mainstreaming climate change in IW projects
- M&E Plan (results frameworks, indicators, reporting)
- TDA/SAP activities
- Ecosystem monitoring
- Climate change scenarios and linkages to marine ecosystems
- Demonstration activities within IW projects
- Stakeholder involvement in climate change adaptation
- Incorporating climate change in sustainability and replication strategies

A number of GEF IW Marine projects have already included climate considerations into their activities, including assessments of measures with regards to potential climate change (e.g., the Strategic Partnership for the Mediterranean Large Marine Ecosystem).

(1) Guiding Principles for Mainstreaming Climate Change Within IW Freshwater Projects

The following guiding principles should not be considered prescriptive. It is important to recognize that within regions different models and scenarios are applicable (one size does not fit all):

- "No regrets" or "low regrets" policy;
- Dealing with uncertainty;
- Integration of land use and marine spatial planning (MSP)/management;
- Measures and tools to be implemented could include ICZM, MSP, capacity building and MPAs;
- Informing stakeholders on both mitigation (e.g. carbon sequestration and benefits from C-trading, plus reducing GHG emissions) and adaptation approaches;
- Assisting countries to develop robust policy to adapt to and thereby mitigate the impacts of climate change.

Adaptation to Coastal Climate Change

The guidebook describes the five-step process. Step 1: Assess vulnerability. The vulnerability assessment identifies numerous climate change risks and potential impacts to different sectors. Assessing a coastal area's vulnerability to the impacts of climate change involves understanding: (1) the climate projections for a given region or locale; (2) what is at risk (climate change exposure and sensitivity); and (3) the capacity of society to cope with the expected or actual climate changes (adaptive capacity). Step 2: Select course of action. The first thing in selecting a course of action is to identify the priority climate change risks upon which to focus efforts and resources. Step 3: Mainstream coastal adaptation. It is important to recognize that climate change adaptation presents a fundamental challenge to managing the coastal resources and should be "mainstreamed" into coastal management and developed at all levels. Step 4: Implement adaptation. It is important to strengthen legal framework and enforcement as well as personnel capabilities. Step 5: Evaluate for adaptive management. All evaluations of coastal adaptation measures involve a similar methodology and steps. The steps of the evaluation include the following: Specify evaluation questions, elaborate an evaluation plan, conduct the evaluation and communicate the results.

USAID: Adapting to coastal climate change: A guidebook for development planners, 2009. See [36](#).

Development and Climate Change

The idea of the mainstreaming approach is to assess climate change impacts and vulnerabilities in the context of development. In a more simple way it can be said that the aim of mainstreaming assessments is to ensure that current, as well as future development policies, are well adapted to the climate, and this can imply that some adaptation options are recommended. This way the mainstreaming approach aims at assessing the relationship between the climate and development in general, without giving specific consideration to distinguishing anthropogenic climate change impacts and vulnerabilities from climate vulnerability of development policies per se. A stepwise mainstreaming approach for assessing adaptation can include five analytical elements: Element 1: Climate Conditions, Variability and Future Changes; Element 2: Selection of Development Indicators; Element 3: Assessing the Relationship between Climate Variables and Development Indicators related to Specific Activities; Element 4: Adaptation options; and Element 5: Assessment of adaptation options, in order to measure the costs and development impacts of implementing these options.

Development and Climate Change: A Mainstreaming Approach for Assessing Economic, Social, and Environmental Impacts of Adaptation Measures, Environmental Management, 43, 2009. (See [39](#)).

Mitigation

The local change in sea level at any coastal location depends on the global mean sea-level rise and regional deviations from this mean. Acceleration of the global-mean rise trend during the 20th century is difficult to detect because of the limited number of gauges with long records and the long period natural variability measured at each gauge. Projections of future sea level need to include both the response to future emissions of greenhouse gases and the ongoing response to past emissions. This latter component is the commitment to sea-level rise and will continue for many centuries into the future, even if the concentration of greenhouse gases and aerosol particles in the atmosphere were stabilized immediately. Future sea-level rise can be estimated for different types of scenario using climate models of varying complexity. In addition to rising sea levels, future global climate change is expected to directly alter many other environmental factors. Mean temperatures are projected to increase around the globe. Mitigation will only significantly reduce the future rate and magnitude of sea-level rise after the middle of the 21st century and the largest benefits occur long into the future. Unmitigated impacts could be significant and are reduced to varying degrees by mitigation. Hence based on the available knowledge, a combination of mitigation and adaptation are required in coastal areas and both policies need to be assessed in an integrated manner to develop a response to climate change. Such assessment should also include the immediate benefits of adaptation in terms of the increased capacity to deal with climate variability.

Benefits of mitigation of climate change for coastal areas, Global Environmental Change, 14, 2004. (See [15](#)).

(2) Strengthening IW Freshwater Projects M&E Activities with Respect to Climate Change

Under GEF-5 (and future replenishments) there is an expectation that all IW projects will include climate variability and change considerations as mainstreamed project elements. In addition to the technical issues surrounding climate change (e.g., in developing scenarios within a TDA/SAP to ensure that measures are adequately "climate proofed") there is a need to adequately reflect climate change within project management and reporting—specifically within project results frameworks and M&E activities.

Climate Variability and Change

The Resource Book comprises four main sections, reflecting the four principal dimensions of the climate issue- the changing climate, the observed and potential impacts, and the two broad categories of policy responses and actions, namely mitigation and adaptation. Climate and Sea- level Variability and change in the mentioned area suggest that it will continue to be dominated by the inter- annual variability, due to the enhanced greenhouse effect the Region will likely be warm. Consequences of Climate and Sea- level Variability and Change in the Pacific Island Countries may include extensive coastal erosion, droughts, coral bleaching, more widespread and frequent occurrence of mosquito- borne diseases, and higher sea levels. Mitigation, as a response to Climate and Sea-level Variability and Change, in Pacific Island Countries is normally best implemented through a collaborative partnership involving at least some of the key players: developed countries, government, the private sector, community- based organizations, investors, donors and the public at large. Adaptation is other response. It requires enhancement of institutional capacity, developing expertise and building knowledge. It also needs an external entity to facilitate the adaptation process.

SPREP: Climate Variability and Change and Sea level Rise in the Pacific Islands Region A Resource Book for Policy and Decision Makers, Educators and other Stakeholders. See [37](#).

As part of the expected and [recommended approaches for project management](#) and following the checklists given above, the overall approach to the M&E Plan (including indicators, baseline figures and results frameworks) are all reviewed during the inception phase. In addition, the need to respond to GEF Agency reporting requirements (including PIRs) necessitates an updating of all indicators and values on (at least) an annual basis. The expectation is that the project management unit, in discussions with the PSC will review and amend these basic project documents to ensure that climate change is reflected in both the indicators (e.g., long-term monitoring programmes or data recording procedures in-place: see section below on ecosystem monitoring) and that activities (such as demonstration actions, capacity strengthening and stakeholder awareness) include information on climate variability and change, and are designed to be resilient to any climate change impacts.

Key elements from the M&E Plan that should be reviewed for climate issues include:

- [Project Result Frameworks](#): Are outputs and activities reflecting the significance of climate change within the project area?
- [Project indicators](#): Are the GEF "types" of indicators (P, SR, ES/SE) reflecting climate issues: For example, are [IMC](#) including climate within policy plans? Are potential coastal and marine areas related stress reduction actions (ICZM, MSP, MPA, municipal and industrial wastewater treatment, protected wetlands, reduced fishing pressure measures, invasive species reduction) including potential climate change scenarios in their planning and implementation? Have estimates of sea level rise included impacts on coastal infrastructure?
- [Reporting](#): Are activities that are being undertaken identifying climate adaptation benefits (for example from training of stakeholders, demonstration actions, etc.).

For general guidance on GEF IW Project M&E, see the [Project Management Manual](#).

(3) TDA/SAP Activities

Climate variability and change considerations are an integral aspect of undertaking a Transboundary Diagnostic Analysis (TDA) as a component of developing a Strategic Action Programme (SAP) for the shared water bodies within an IW project. There has been significant debate in previous TDA/SAP projects on whether climate change is a transboundary problem. However, climate change has been recognized as a significant driver (or root cause) of a number of transboundary problems (such as changes in biodiversity, loss of ecosystems, eutrophication and invasive species). Consequently, the effects of climate change (in terms of cause and impact) need to be well understood to ensure that future interventions are both resilient and adaptive.

LMEs and GEF

The role of the GEF in supporting LME projects, with a focus on the GEF's International Waters portfolio and the distribution of financial assistance to countries participating in LME sustainable development projects around the globe. Detailed analysis of climate change issues in LMEs. Special focus is on acidification and impacts on marine resources.

UNDP/GEF: Frontline Observations on Climate Change and Sustainability of Large Marine Ecosystems, 2012. See [20](#).

Within the TDA, it is important that an assessment is made of the possible scenarios that could result from climate change and their impacts on the water resources and ecosystems, and that these scenarios are utilized within the planning activities of the SAP (e.g. developing management actions or measures to respond to the transboundary problems) that are robust and resilient to potential climate change impacts. The concept of "no regrets" (those measures that turn out to be of benefit no matter how, or if the predicted climate change impacts materialize) has been utilized by a number of guidance documents in adaptation actions.

For more information see documents [10](#), [11](#), [15](#), [22](#), [26](#), [35](#), [36](#).

Sea Level Rise

Over the last decade, there has been significant progress in understanding future sea level change and, as a result, confidence that global averaged sea level is rising and will continue to rise through the twenty-first century and beyond has increased. The amount of rise is dependent on future emissions of greenhouse gases. There are likely to be significant regional differences in the amount of sea level change from both ocean dynamic responses and changes in mass distribution, principally from a changing cryosphere. However, major deficiencies in our understanding remain, and current projections still cover a broad range of values regardless of emission scenarios. Perhaps the major challenge is the response of the ice sheets, particularly those parts grounded below sea level. A second set of challenges relates to better understanding of the regional distribution of sea level change, short-term prediction of sea levels, and the impacts of climate change on extreme events.

Understanding and projecting sea level change, Oceanography 24 (2), 2011. (See [11](#)).

(4) Ecosystem Monitoring

The availability of reliable monitoring data, or the development of a new system is imperative to build reliable baseline information for many activities. In the TWAP methodologies (see [60](#) and [61](#)) for the assessment of LMEs and Open Oceans (Vols. 5 and 6) there is clear guidance how these ecosystems should be monitored with respect to expected impacts of climate change and variability. Anthropogenic climate change is identified as one of the priority cross-cutting issues for both water systems. Both methodologies propose sustainable monitoring systems for climate variability and change. It is important for IW Marine Projects to consider the sustainability of such systems (collection of samples, analyses, data processing and interpretation, etc.) to ensure that countries and regions have the means to detect long-term changes and provide reliable information for management actions and stakeholder communications.

Monitoring is an expensive process and ensuring that the objective of the monitoring is well specified will help to minimize these costs for both the project and subsequently for national sustainability. A basic monitoring programme should consider collecting information on targeted parameters (e.g. ocean temperature, global mean sea level, ocean acidification) to detect and/or assess the overall ecological condition of the marine ecosystem.

Indicators should be simple (easy to understand and to measure), reliable (conceptually and methodologically well founded) and affordable. Physical indicators of potential climate change consist of ocean forcing functions (atmospheric and hydrological) as well as sea-ice and oceanographic properties, whilst biological indicators consist of five groups of indicators related to organisms (behavioural aspects, state of the body, and phenology of biological events), to populations (recruitment, mortality, numbers and geographical distribution) and to community structure (biodiversity, structure and functioning). These represent a minimum suite of indicators needed to address climate change issues and determine possible causes of (marine) ecosystem changes. (See [3](#)).



Large Marine Ecosystems

The methodology for assessment of Large Marine Ecosystems (LMEs) was developed under the Global Environment Facility (GEF) medium size project (MSP) "Development of the Methodology and Arrangements for the GEF Transboundary Waters Assessment Programme (TWAP)". LMEs, 64 of which have been defined globally, are natural regions of coastal ocean space encompassing waters from river basins and estuaries to the seaward boundaries of continental shelves and seaward margins of coastal currents and water masses. They are relatively large regions of 200, 000 km² or more, the natural boundaries of which are based on four ecological criteria: bathymetry, hydrography, productivity, and trophically related populations. The documents provide methodological guidelines to execute the LMEs assessment. The approach to the assessment and management of LMEs is based on five modules, with corresponding suites of indicators: Productivity, Fish and Fisheries, Pollution and Ecosystem Health, Socio-economics, and Governance. A central theme of TWAP is the vulnerability of ecosystems and human communities to natural and anthropogenic stressors, and impairment of ecosystem services. A conceptual framework was developed that explicitly shows the links between human vulnerability and natural and anthropogenic stressors, ecosystem services and consequences for humans (with governance as an overarching concept), so that cause and effect can be better identified. This framework also accommodates other ecosystem services in addition to fish and fisheries. Further, it incorporates the five LME modules and integrates ecological, socio-economic, and governance indicators into a unified LME assessment framework. Special reference is given to natural drivers such as climate variability and the global threat of climate change.

UNEP: Methodology for the GEF Transboundary Waters Assessment Programme. Volume 5. Methodology for the Assessment of Large Marine Ecosystems. (See [60](#)).

Open Oceans

A sister volume to Reference 60. For the purposes of TWAP, the open ocean is defined as the ocean areas beyond the defined LME areas. The proposed TWAP open ocean assessment will address these challenges through a globally scoped assessment that directly addresses four broad themes: climate, ocean ecosystems, fisheries, and pollution. Rather than carving the open ocean into assessment units based on natural system criteria (which can vary depending on the scientific discipline consulted, and whether the surface, mid, or deep ocean is being considered), the assessment will take the cue from the human system side and the global governance arrangements already in place and focus on a global thematic assessment. Special section is related to climate change and variability. The assessment issues covered in this section are linked to human emissions of greenhouse gases, which create a natural system stress by changing the physical and chemical environment of the open oceans. The physical changes having direct consequence for human population are sea-level rise, increased ocean heat content, changes in global patterns of rainfall and drought, impacts on corals, primary productivity and distribution and transport of oxygen. Chemical change discussed is ocean acidification. The report describes a number of indicators related to climate change.

IOC-UNESCO: Methodology for the GEF Transboundary Waters Assessment Programme. Volume 6. Methodology for the Assessment of the Open Ocean. (See [61](#)).

(5) Climate Change scenarios and linkages to water resources

IW Marine Projects need to utilize information from various global circulation models to develop a range of scenarios that will be accepted by governments within the region on potential climate change. These can then be utilized, together with socio-economic models assessing industry, agricultural, population changes to provide estimates of water resource availability and demand, and potential impacts on the dependent ecosystem health. Such approach has been adopted in the UNEP-MAP GEF MedPartnership project, where a specific project on adaptation to climate variability and change in coastal areas through ICZM was developed. The approach utilizes, among other, the DIVA model, which is a method for building modular integrated computer models by bringing together knowledge from natural and social disciplines. The explicit incorporation of adaptation is an important innovation that DIVA contributes to vulnerability research and modeling. The impacts calculated do not only depend on the scenarios but also on the adaptation strategy. The DIVA tool enables users to choose scenarios and adaptation strategies, and to compare results for different scenarios and adaptation strategies. While DIVA is applied for large areas (region and above), the specific methodology is utilized to down scale it to the local level.

Pelagic Communities

Spatio-temporal structure of the SST across the ocean basin scale explored. An understanding of the spatio-temporal structure of plankton abundance and its temporal drivers is of interest to marine policy makers because of the impact the plankton has on the rest of the marine ecosystem and to various industries such as fisheries. Even though there is a general trend towards rising temperatures, there are regions of the North Atlantic that have been cooling over the past few decades, as well as other regions that have been warming at a quicker rate. The reasons for this spatial heterogeneity comprise various physical features, such as bathymetry, currents and the positioning of high and low pressure centers. The Atlantic Multidecadal Oscillation (AMO) influences temperature changes across the North Atlantic but this influence is stronger where the effects of overturning ocean currents are particularly influential. The AMO may also have an impact on the occurrence of hurricanes in the Atlantic. Since it is thought to be connected to the circulation of the North Atlantic, the AMO might influence plankton abundance through changes in circulation rather than changes in temperature.

Multidecadal Atlantic Climate Variability and its Impact on Marine Pelagic Communities, Journal of Marine Systems, In Press. (See [1](#)).

See Documents [1](#), [3](#), [6](#), [9](#), and [17](#) for more information.

(6) Demonstration Activities

Most GEF IW Marine Projects include some demonstration activities as a precursor to up-scaling and/or replication (See [PMM information on Demonstration Activities](#)). Projects should ensure that these activities are undertaken with potential climate change in mind where appropriate and this necessitates considering:

- Detailed assessment of impacts of climate variability and change at the demonstration site;
- Capacity development and awareness raising activities on climate change and adaptation to strengthen local skills on these issues;
- Reviewing the design of activities involving on-the-ground measures to ensure they comply with good practice such as 'no regrets' concepts;
- Implementing various tools and techniques that would help assess climate change and variability impacts and plan adaptation strategies. (See [23](#), [24](#), [25](#), [26](#), [27](#), [30](#), [31](#), [32](#), [34](#), [39](#), [40](#), [43](#), [48](#), [50](#), [51](#)).
- Encouraging monitoring activities that will compile data as a baseline and to identify means to sustain the collection to establish a long-term data set;

Strategic Environmental Assessment

A well-performed Strategic Environmental Assessment (SEA) can fulfill one or more of the following functions in relation to climate change adaptation: (i) an independent analysis of the likely performance of existing or new Policies, Plans Programmes prepared without reference to climate change in light of new climate change predictions (effectively a form of climate proofing); (ii) an integrated planning and assessment process designed both to generate and test the response of PPP options to different climate scenarios, which are actively explored as part of the SEA; and (iii) a study process focusing entirely on predicting and quantifying the likely effects of climate change itself within a given area. The extent to which climate change considerations can be incorporated into an SEA, the level of detail required in the SEA process, and the relevance of the various questions outlined below, will depend on the entry point and the development activities and processes.

OECD: Strategic Environmental Assessment and Adaptation to Climate Change, 2010. (See [31](#)).

(7) Stakeholders

See Documents [10](#), [22](#), [28](#), [29](#), [35](#), [38](#), [59](#).

"Stakeholders" are key partners of all IW Marine Projects and as such the PCU has an obligation to keep the many interested groups updated on aspects of the project ([See PMM for more information](#)). It is critical climate change in ocean and coastal governance in the context of reducing vulnerability of the poor, to maintain sustainable livelihoods and support sustainable development.

Role of Community Organizations in Managing Marine Resources

Local-scale actions over medium-term timeframes (i.e. <5 years) can include strengthening community groups responsible for managing coastal resources, improvements in coastal infrastructure, and migration to non-coastal areas. In much of the western Indian Ocean, community-based organizations are increasingly empowered with the responsibility of managing coastal resources such as reef-based fisheries. In the short term, national scale efforts to provide social safety nets may help to increase adaptive capacity by preventing the marginally poor from falling into poverty traps and reduce exposure to climate change. International-scale policy actions are much more general, with little specificity to coral reefs. Effectively adapting to changes in coral reef fisheries will also require governance of broader marine seascapes. Decades of research on common property institutions have suggested that there is a clear need for governance rules to be congruent with local social and environmental conditions.

Vulnerability of coastal communities to key impacts of climate change on coral reef fisheries, Global Environmental Change, 22, 2012. (See [5](#)).

Stakeholder engagement occurs throughout the project cycle, from inception through policy development, implementation and monitoring. Initial steps (for example stakeholder mapping and analysis), essential to projects undertaking a TDA/SAP are also beneficial to all GEF IW Marine Projects.

During the main implementation of the project, the PCU should consider preparing information targeted to specific groups of stakeholders (e.g. government institutions, communities, schools, etc.) to convey both the issue of climate change and the need for adaptation and the approaches to be adopted by the project. This will further increase overall awareness of the issues and encourage sustainability at all levels.

Mainstreaming into Development Institutions

The paper reviews the context and challenges to environmental mainstreaming (EM), discusses what it takes to achieve effective EM, and provides a roadmap for selecting operational EM methods and tools. The focus is on those approaches and tools which directly help to shape policies, plans and decisions; not the wider array of secondary tools applied to implement those decisions. The conclusion is that too many tools are being 'pushed' by outside interests, and too few locally developed (and more informal, or less expensive) approaches are widely known. There is not enough 'demand-pull' information from potential users. Neither is there enough information available that helps them to select the right tool themselves – as opposed to taking what others want or suggest/promote. Given the prevalence of 'top-down' material promoting particular mainstreaming techniques on the one hand, and the paucity of really effective mainstreaming to date on the other, the conclusion is that environmental mainstreaming capacity will be much stronger if stakeholders are able to select tools, methods and tactics that are relevant to their context. Some of these will be widely used and others still in development; some are easy to do and others demanding of skills and money; some are effective but others are not.

IIED: The challenges of environmental mainstreaming into development institutions and decisions, 2009. (See [59](#)).

(8) Adaptation Strategies

All IW projects should facilitate the inclusion of appropriate strategies to adapt to climate change within the project activities, especially demonstration actions and to ensure that strategies to assist with the sustainability of activities address potential climate change issues. The adaptation strategies should also be a constitutive element of [SAP](#) and should be integrated into it.

As the UNECE "Guidance on Water and Adaptation to Climate Change" states, "...the adaptation strategies and measures should be based on the results of vulnerability assessments as well as on development objectives, stakeholder considerations and the resources available. If little or no information is available for structured vulnerability assessments, adaptation should be based on available general information combined with expert and local knowledge. Effective adaptation strategies are a mix of structural and non-structural, regulatory and economic instruments, and education and awareness-raising measures to tackle short-, medium- and long-term impacts of climate change. Given the uncertainty associated with climate change, win-win, no regret and low regret measures should be chosen as a priority."

Adaptation in the Pacific

The Pacific Adaptation to Climate Change (PACC) project has put together this guide as a response to the need from PACC-participating countries to integrate climate change risks into their national and sector strategies and plans, and budgetary processes. The recommended approach combines standard policy cycles commonly used in the Pacific with analytical inputs from the climate risk management (CRM) framework. This forms a seven-phase process representing a broad outline of how to mainstream climate risk into development planning and policy processes, with analytical inputs, outputs and key decisions described for each step. Steps include: preparatory activities; situation analysis; problem analysis; solution analysis; design of the outputs; implementation, monitoring and evaluation; and review. The guide operates at two levels: strategic level mainstreaming and "on the ground" level mainstreaming. The process is illustrated with detailed case studies drawn from the region.

SPREP and UNDP: Mainstreaming Climate Change Adaptation in the Pacific: A Practical Guide, 2013. See [52](#).

See Documents [16](#), [32](#), [33](#), [44](#), [45](#), [46](#), [47](#), [49](#) and [52](#) for more information.

(9) Sustainability and Replication Strategies

All GEF IW Marine Projects are expected to develop sustainability plans and to encourage replication, both within the project region and globally by dissemination of experiences and lessons (See [PPM Section on Sustainability and Replication](#)). Both replication and sustainability of project activities should take potential climate change (and variability) into consideration in the development of strategies.

2.2 Checklists on Climate Change Issues for IW Marine Project Implementation

The following checklist of potential issues and actions are included to indicate to IW projects what should be considered at key stages of an IW project and who the likely information holders or decision makers are with respect to GEF IW project implementation.

The "Issues" column identifies the main topics that should be considered at the different stages of the project to address climate change in freshwater systems. "What" provides a brief description of the activities that need to be undertaken. "Who" identifies the main sources of information and/or decision makers within the project. For examples of approaches or recommendations the reader is directed to Part Three of this manual and to the reference section of the Project Managers Manual.

2.2.1 Inception phase

Issues and Actions for Consideration in the Inception Phase				
Issue	Defining boundary conditions	Identifying sources of local, national, regional or global sources of information	Identify and secure expert assistance on climate change	Review and Amend the Project's M&E system
What	<p>Agree on geographical boundaries of coastal and marine ecosystems. They should be defined more precisely than in the Project Document. The boundaries may be natural (respecting the principles of Ecosystem Based Management, see http://www.ebmtools.org), functional (respecting boundaries of activities within the socio-economic systems), and planning (respecting administrative and planning boundaries), or integrating all three.</p> <p>Define time period for climate change issues consideration (e.g. 10, 25, 50 years) and link with coastal land use and marine spatial planning horizon, which is shorter (20 to 30 years for strategic plans). The difference in time horizons should not be considered as an obstacle. Climate change models/scenarios, which provide inputs for coastal and marine plans, are indicative only.</p> <p>Scope issues at hotspots that are most impacted by climate variability and change.</p> <p>Identify responsible sectors and ministries (fisheries, tourism, maritime affairs, transport, infrastructure, industry, environment, spatial planning, etc). The climate change issue, as well as coastal and marine planning, may be the responsibility of different ministries, and an institutional analysis should be made during the Inception Phase to map the institutional responsibilities.</p>	<p>General source of information on all subjects mentioned below is the UNFCCC website (https://unfccc.int/2860.php). Information could also be found on web sites of relevant international organizations, but also on national web sites for specific country information.</p> <p>The project should identify sources of information on specific subjects including:</p> <ul style="list-style-type: none"> Climate change models and scenarios, generally found on UNFCCC and IPCC web sites, but also http://www.geog.ox.ac.uk/research/climate/projects/undp-cp/, or http://www.ipcc-data.org/ar4/gcm_data.html Socio-economic trends (e.g. population changes, coastal uses, urbanization, open ocean fisheries, shipping, energy exploration and extraction, etc.) (see, for example, https://unfccc.int/ghg_data/ghg_data_non_unfccc/items/3170.php) Monitoring information (e.g. temperature, ocean warming, acidification, biodiversity, sea level rise, extreme weather events, arctic sea ice, rainfall, etc.) Databases and data owners within the region (for example ministries, institutes, academia - these will be identified by national experts and / or counterparts and approved for use in the project by the PSC) UNFCCC national reports and communications 	<p>The project should identify national/regional expertise needed to, for example:</p> <ul style="list-style-type: none"> Assess climate change reports and information Establish validity of available reports and information for climate change consideration in the project Identify institutions involved in the UNFCCC Communications Provide specific climate change inputs developing management tools and instruments (an example of a ToR for a National Expert) 	<p>Assess and eventually amend the project results framework for climate change related activities</p> <p>Define set of indicators to assess impacts on climate change affected activities (ocean CO₂ concentration, pH, ocean temperature, global mean sea level, etc.)</p> <p>Identify sources of information to provide baseline on climate issues and on-going monitoring information (coastal and marine resources, climate, socio-economic aspects, etc.)</p>
Who	PCU PSC Inception Meeting	PCU PSC National focal points Ministries State and local institutions Scientific institutions	Inter-ministerial committees National Governments Project Partners National Universities	PCU PSC

Issues in the Inception Phase: Open Oceans

The basic hypothesis of the paper is that combined impact of warming, acidification and deoxygenation is already having a dramatic effect on the flora and fauna of the oceans with significant changes in distribution of populations, and decline of sensitive species. In many cases, the effects of other human impacts, such as pollution, eutrophication and overfishing, increase the impacts of warming, acidification and deoxygenation. The interactive effects of these impacts mirror similar events in the Earth's past, which were often coupled with extinctions of major species' groups. The paper reviews the observed impacts and, using past episodes in the Earth's history, set out what the future may hold if carbon emissions and climate change are not significantly reduced with more or less immediate effect. The paper gives very good description of the three basic impacts and can be very useful during project development phase.

Climate change and the oceans – What does the future hold? Marine Pollution Bulletin, 74, 2013. (See [62](#)).

Issues in the Inception Phase: Large Marine Ecosystems

In general for the European Seas considered here the pattern of sea temperature over the last century has fluctuated from generally cold conditions in the early 1900s to a warm period from the 1920s to the 1950s, cool again through the 1960s and 1970s, followed by recent warming that commenced in the mid 1980s. Many marine species are moving northwards. The rate and direction differs for diverse seas and species. Enclosed seas, such as the Baltic, the Mediterranean and the Black Sea, have only small and primarily east–west orientated corridors, which may restrict northward migration in these areas. For most open seas, there is evidence of species moving northwards and/or northern species being replaced by more southern ones. Such changes not only affect the local ecosystems, but also the international fishing industry when commercial species such as cod are involved. It is expected that within open systems there will generally be northward movement, from polar to more temperate species in the more northern seas such as the Arctic, Barents Sea and the Nordic Seas and from temperate to more subtropical species in the southern seas such as the Iberian upwelling margin. It is expected that within open systems there will generally be northward movement, from polar to more temperate species in the more northern seas such as the Arctic, Barents Sea and the Nordic Seas and from temperate to more subtropical species in the southern seas such as the Iberian

Impacts of climate change on European marine ecosystems: Observations, expectations and indicators, Journal of Experimental Marine Biology and Ecology, 400, 2011. (See [3](#)).

Issues in the Inception Phase: Coastal Zones

After reviewing the current national circumstances of MAP Contracting Parties, terms of their physical environment, their major ecosystems and their socioeconomic status, the document establishes a broad indication of sensitivity to climate change. The paper then considers current status of vulnerability and adaptation initiatives across MAP Contracting Parties (CPs), which involves a review of the range of plans and strategies and projects and programmes operative in the region at various temporal and spatial scales. The purpose of the review exercise was to establish a broad measure of the potential adaptive capacity associated with specific CPs. Through the course of this exercise; a number of approaches to coastal adaptation were showcased with a view to highlighting best practice for subsequent application in a Mediterranean context. The measures, options and actions associated with discrete "types" of adaptation were discussed to inform the identification of the most relevant approaches for the complex range of climate change issues to which the MAP CPs are susceptible. The review has identified a number of key issues and information gaps that inhibit a proactive and coordinated approach to climate change adaptation in the Mediterranean coastal zone. Overall, the information contained within this report provides the necessary background information to develop recommendations for PAP/RAC, to support adaptation to climate change impacts in coastal zones, but could also have wider implications due to generic nature of many recommendations in the report.

PAP-RAC: Climate Change in Coastal Zones of the Mediterranean: Background Paper, 2010. (See [63](#)).

Issues in the Inception Phase: Sea Level Rise

Over the twentieth century, global sea level rose about 17 cm. While this change may seem small, it will have many significant effects, most particularly in terms of reducing the return periods of extreme water levels and promoting an erosive tendency for coasts. There are significant actual and potential impacts of relative sea level rise in deltas and in and around subsiding coastal cities in terms of increased water logging, flooding, and submergence, and the resulting need for management response. Planning for sea level rise is a multidimensional problem that crosses many disciplines and embraces natural, social, and engineering sciences. Sea level rise has important implications for coasts worldwide, but the actual outcome will depend on our responses, both in terms of mitigation and adaptation, and their successes or failures. Coastal cities worldwide will be a major focus for adaptation efforts because of their concentrations of people and assets and given their concentration of people and assets, and their ability to fund large investments. Developing countries will pose adaptation challenges, especially in deltaic areas and small islands, which are the most vulnerable settings. The issues tackled in the paper include: (1) How to best plan for the threat of sea level rise and its implications? (2) What are the major responses are possible? and (3) How to carry out adaptation and mitigation responses.

Planning for the impacts of sea level rise, *Oceanography*, 24 (2) 2011. (See [10](#)).

2.2.2 Implementation phase

Issues and Actions for Consideration in the Implementation Phase					
Issue	Commissioning studies to better understand the issue of climate change at the ecosystem level	Assess climate change impacts in demonstration activities	Developing monitoring plans	Reviewing adaptation approaches	Maintaining M&E parameters and updating results framework
What	<p>Assess existing climate models outputs (see Part Three for examples of models and assessment)</p> <p>Agree on baseline conditions and socio-economic factors (state of coastal and marine resources: fisheries, coral reefs, mangroves, etc.; demand for resources; population growth in coastal areas; employment by sector; coastal urbanization; health of the population in coastal areas; etc. – all issues that have demand for, or impact on marine resources)</p> <p>Develop climate change trend scenarios at the ecosystem level, together with sector representatives</p> <p>Assess impacts on and conflicts between sectors caused by climate change (e.g. tourism and recreation; fisheries and aquaculture; coastal infrastructure and shipping; energy extraction and fisheries and tourism, etc).</p> <p>Value Marine Ecosystem Services to create baseline for assessment of potential impacts climate change might have on marine ecosystems, see 69, 70, 71.</p> <p>Understand (and explain) the notion of uncertainty in the outputs. Uncertainty is a very critical issue in climate studies and it is important to inform the decision-makers on the limits of climate models. The resulting measures have to have the uncertainty built in. According to many, uncertainty in future climate change, due to natural variability, is unlikely to be reduced, even if climate models will be improved. See 72, 73, 74.</p>	<p>The project should consider the specific needs of demonstration activities to ensure they both reflect potential climate change impacts and are implemented to take account of any changes (following a 'no-regrets' approach for example). These consideration could include:</p> <ul style="list-style-type: none"> Review demonstration activities to ensure 'no regrets principles' is followed with regards to interventions Strengthen local understanding on mitigation of climate impacts and adaptation to change Develop awareness of climate variability and change by local monitoring of conditions and trends 	<p>The project should assess if the monitoring plans in operation to collect ecosystem status or socio-economic data are robust and sensitive to climate variability or change to provide the baseline for long-term datasets. Such considerations should include:</p> <ul style="list-style-type: none"> Utilize national/regional data sets on long-term monitoring (marine quality, coastal erosion, biology, sediments) for assessing impacts of storms, pollution, biodiversity issues Assist with developing/implementing programmes to collect/analyze marine resources and climate data where needed Identify long-term sustainability issues to assess climate change over an extended period (post-project). National commitments such as endorsement of a SAP could assist with this. 	<p>Review current activities within country/region on adaptation approaches and evaluate climate change scenarios, and identify lessons for incorporation within IW Marine Project.</p>	<p>Ensure collection and analysis of data for project indicators (if possible, Stress Reduction Indicators and Environmental and Socioeconomic Indicators) and periodic review of project results framework to assess / report progress with regards to adaptation to climate change</p>
Who	PCU Stakeholders	PCU National Experts Stakeholders	PCU PSC National Experts	PCU National Experts	PCU PSC

Scenarios

Findings of the paper support the CMIP3 models as a useful source for climate projections on regional scales for marine ecosystem interests. Care must be exercised in their application with respect to selecting a reliable subset of models when extracting relevant variables in that not all models are equally reliable. Therefore, it is probably good practice to exclude models that clearly do not characterize a system properly to the extent this can be determined given limited data sets for validation. It is also a good idea to retain as many models as possible to form an ensemble forecast in order to reduce the errors intrinsic to individual models and provide important information on the uncertainty in these projections on the whole.

Climate projections for selected large marine ecosystems, *Journal of Marine Systems*, 79, 2010. (See [6](#)).

Socio-economic Assessment: DIVA Model

DIVA has been developed to meet the demand for new information on coastal vulnerability on a global scale, addressing important limitations of the earlier global studies. The DIVA method consists of two parts: a modeling framework and semi automated development process. The DIVA method has been successfully applied to develop the DIVA tool. The DIVA tool comprises four main components: (1) A detailed global database with biophysical and socio-economic coastal data; (2) global and regionalized sea-level and socio-economic scenarios until the year 2100; (3) an integrated model, consisting of interacting modules that assess biophysical and socio-economic impacts and the potential effects and costs of adaptation; (4) a graphical user interface for selecting data and scenarios, running model simulations and analyzing the results. Recently, DIVA has been downscaled to the national level in Croatia and Tunisia within the UNEP MAP GEF project "Integration climate variability and change into national strategies to implement the ICZM Protocol in the Mediterranean".

Integrating knowledge to assess coastal vulnerability to sea-level rise: The development of the DIVA tool, *Global Environmental Change*, 19, 2009. (See [27](#)).

Assessing Risks in Coastal Zones

Many coastal populations are at risk from flooding – particularly when high tides combine with storm surges and/or high river flows. The estimates of global mean sea-level rise in the Special Report on Emissions Scenarios of the IPCC range from 22 centimetres to 34 centimetres, between 1990 and the 2080s. The risks to human settlements could be reduced if people and enterprises could be encouraged to move away from the coast, or at least from the most risk-prone coastal locations. Even as the seaward risks associated with climate change are increasing, the areas most at risk are experiencing particularly high population growth. There is considerable variation within regions and income categories, and there are a number of features that can lead a country to have a large share of its urban and rural populations in the Low Elevation Coastal Zone (LECZ). These include long coastlines (relative to the country's size), wide and heavily populated coastal lowlands, and sparsely populated interiors. Most of the countries with large populations in the LECZ are also among the most populous countries overall, with large Asian countries dominating. The countries with large shares of population (or urban population) in the LECZ are a more varied group, and include countries characterized by each of the three factors. Looking to the future, the responses to the growing risks to coastal settlements brought on by climate change should include mitigation, migration and modification.

The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones, *Environment and Urbanization*, 19, 2007 (See [14](#)).

SEA and Climate Change

The SEA Directive requires authorities to assess the likely significant effects of their plans and programmes on "the environment, including on issues such as biodiversity, population, human health, fauna, flora, soil, water, air, climatic factors, material assets, cultural heritage including architectural and archaeological heritage, landscape and the interrelationship between the above factors". The document states that climate change needs to be considered at various stages of the SEA process.

USEPA: Strategic Environmental Assessment and Climate Change: Guidance for Practitioners, 2004. (See [50](#)).

Adaptation Approaches

At EU level, the integration and mainstreaming of climate change in sectoral EU policies is the key policy 'lever' (areas where the EU has tools to act at its disposal) for advancing adaptation and alleviating pressures on human and natural systems. Integrated exercises assessing future consequences of climate change use tools and methods that incorporate assumptions and scenarios for both socio-economic developments and climate change variables (e.g. temperature, precipitation). Although the socio-economic variables are usually clearly differentiated from the climate change variables in terms of data inputs or assumptions, the majority of studies report their combined effect. There is no "attribution" made to the role played by individual causes.

EEA: Adaptation in Europe: Addressing risks and opportunities from climate change in the context of socio-economic developments, 2013. (See [22](#)).

An integrated spatial planning method, which balances the need and conflicting objectives of stakeholders while reflecting the dynamic changes in coastal systems produced by spatial planning solutions. This study has developed an optimization- stimulation model that is called Multi- Objective Programming and System Dynamic (MOPSD) to assist with spatial planning in coastal regions. One of its main goals is to mitigate the impact of climate change. MOPSD stimulates coastal area development under various spatial planning strategies that are based on the size of the coastal buffer zones. Decision makers are able to select optimal alternative within a dynamic environment for climate change adaptation in coastal zones. A case study of Chijin is shown where the MOPSD modeling approach generates superior solutions that each of the two traditional (MOP and SD) methods on their own. This is mainly attributed to the consideration of various deterministic and dynamic characteristics when evaluating the future of coastal regions.

An integrated spatial planning model for climate change adaptation in coastal zones, Ocean & Coastal Management, 66, 2012. (See [26](#)).

2.2.3 Project closure

Issues and Actions for Consideration in the Project Closure		
Issue	Assessment of project activity sustainability	Develop post project monitoring strategy
What	The project should make a final assessment of how activities implemented under the GEF project can be sustained in a long term, and if they are indicating their sensitivity/robustness to climate variability and change scenarios (essentially have the demos and other activities been undertaken in accordance with the 'no regrets' concepts). This analysis should be an element of the final project 'exit strategy'. This analysis should be linked to the project's exit strategy.	As part of the exit strategy, the project should assess: <ul style="list-style-type: none"> • How will monitoring programmes encouraged by the project be sustained post-project? • How will data be collected/analyzed? • What is the level of commitment of national (or regional) authorities to continue to collect and report data (to all stakeholders)?
Who	PCU PSC National / Regional Partners	National / Regional Partners National authorities

2.3 Specific Climate Change Issues Related to Marine Ecosystem Type

The issues identified in the next pages are not exhaustive but indicative of the types of issues marine IW projects should be considering. A simple summary of key issues is presented for LMEs, open oceans and coastal zones/areas. However, projects should be aware that the inter-linkages between these marine ecosystem types could be significant.

Climate variability and change over the past century have already had significant and measurable effects on ecosystems, societies, economies and health. Climate change contributes to sealevel rise and to the frequency and intensity of floods, droughts and other extreme weather events. Examples of climate variability include extended droughts, floods, and conditions that result from periodic El Niño and La Niña events. Climate variability can cause abrupt disruptions, such as floods, droughts, or tropical storms. These disruptions can take a major toll on a country's economy if a significant part of economic activity is sensitive to the weather and climate as is, for example, the case with coastal economies. Future changes in exposure, vulnerability, and climate extremes resulting from natural climate variability, anthropogenic climate change, and socioeconomic development can alter the impacts of climate extremes on natural and human systems and the potential for disasters.

(1) Large Marine Ecosystems

Pressures on ecosystems originating in the sea and associated impacts:

- Sea level rise (loss of habitats);
- Impacts on fisheries (overall decline in productivity, eutrophication and coral mortality leading to reduced fish catch, loss or shifts in critical fish habitat);
- Acidification (damage to coral reefs);
- Increased salinity;
- Increased temperature (temperature shifts causing migration of fishes, temperature changes);
- Increased frequency of extreme weather events (increase in category 4 and 5 cyclone activity)



Rapid Warming of LMEs

The U.K. Meteorological Office Hadley Centre SST climatology was used to compute 50-year time series (1957–2006) of sea surface temperature (SST) and examine SST trends in the World Oceans' 63 LMEs. Reflecting a global trend, warming in most LMEs accelerated in late 1970s–early 1980s. Of the 63 LMEs, 61 warmed and only two cooled in 1982–2006. Linear SST trends for each LME show a distinct global pattern of rapid warming in three regions: around the Subarctic Gyre; in the European Seas; and in the East Asian Seas. Decadal rates of SST warming in these three regions are 2–4 times the global mean rate. These estimates are rather conservative as numerous independent studies based on various data sets reveal even higher rates in the 1990s–2000s, up to 10–12 times the global mean rate. The Subarctic Gyre warming is likely caused by natural variability related to the North Atlantic Oscillation. The proximity of the European and East Asian Seas to major industrial/population agglomerations suggests a possible direct anthropogenic effect. Freshwater runoff in the European and East Asian Seas likely plays a special role in modulating and exacerbating global warming effects on the regional scale.

Rapid warming of Large Marine Ecosystems, *Progress in Oceanography*, 81, 2009. (See [7](#)).

Marine Organisms

Given the geographic variation in change in temperature, acidity and other factors, and the varying sensitivity of marine organisms and ecosystems, it is unlikely that any single strategy will alleviate impacts of climate change everywhere. A series of regionally tailored response plans under local governance are required. However, on a global scale, an immediate reduction in CO₂ emissions is essential to minimize future human-induced climate change. Improving models are increasing our ability to predict physical changes in the ocean that will impact marine and terrestrial biology, but we need to progress beyond prediction and monitoring of decline and act to halt degradation. Despite options for intervention, it may already be too late to avoid major irreversible changes to many marine ecosystems. As history has shown us, these changes in the ocean could have major consequences for the planet as a whole.

Impacts of Climate Change on Marine Organisms and Ecosystems, *Current Biology*, 19, 2009. (See [18](#))

See Documents [2](#), [3](#), [4](#), [5](#), [6](#), [7](#), [13](#), [16](#), [17](#), [18](#), [19](#), [20](#), [42](#), [53](#), [54](#) and [60](#) for more information.

(2) Open Oceans

Potential climate change impacts on open oceans to consider include:

- Sea Temperature Rise:

- Accelerated warming of high altitudes and reduced seasonal sea ice zones;
- Increasing stratification of ocean layers;
- Changes in winds and currents;
- Decreasing surface oxygen concentrations;
- Sea level rise;
- Biological implications:

- Pelagic systems (changing species distribution, timing of peak production, regime shifts, reduced fish production);

- Polar and ice-edge (sea ice and habitat loss, increasing primary production and associated trophic responses, physiological impacts leading to species range changes/extinctions);

- Deep seas (changes in carbon flux from surface impact deep sea community composition).

- Ocean Acidification:

- Reduced pH;
- Broad changes in seawater chemistry;
- Impacts on marine biology:
 - Pelagic systems (altered plankton calcification);
 - Polar and ice-edge (detrimental carbonate conditions for planktons, and food web consequences).

- Ocean Deoxygenation:

- Increase in coastal hypoxia;
- Declining oxygen level in tropical areas;
- Formation of "dead zones"

- Carbon storage in the ocean:

- The uptake of CO₂ into the ocean is outstripping its capacity to absorb it, which if continued may cause more severe acidification and carbonate dissolution.

Oceanic Climate Change Policy

Historically it has been difficult to estimate the oceanic anthropogenic CO₂ sink. However there has been much progress over the last decade in measuring oceanic CO₂ and other properties to constrain the net oceanic CO₂ sink. As long as atmospheric CO₂ concentrations are increasing the ocean will attempt to equilibrate and in doing so will absorb a portion of this anthropogenically produced CO₂. The best example of a place where the gross natural ocean is a large source of CO₂, but represents a net sink for anthropogenic CO₂ is in the equatorial Pacific Ocean. The coastal ocean is an important part of the global carbon cycle and it will be important to further explore the CO₂ source/sink debate in the future. The policy analyses from this paper would extend to the coastal ocean, however it is far more difficult to determine the anthropogenic CO₂ uptake within this regime given its heterogeneous nature. There is no doubt however that human activities both on the adjacent coastal land and also within the open ocean could have the potential to change the EEZ anthropogenic CO₂ sink.

Oceanic implications for climate change policy, Environmental Science and Policy, 9, 2006. (See [21](#)).

Fisheries

Evidence of the impacts of anthropogenic climate change on marine ecosystems is accumulating, but must be evaluated in the context of the "normal" climate cycles and variability which have caused fluctuations in fisheries throughout human history. The impacts on fisheries are due to a variety of direct and indirect effects of a number of physical and chemical factors, which include temperature, winds, vertical mixing, salinity, oxygen, pH and others. The direct effects act on the physiology, development rates, reproduction, behaviour and survival of individuals and can in some cases be studied experimentally and in controlled conditions. Indirect effects act via ecosystem processes and changes in the production of food or abundance of competitors, predators and pathogens. Recent studies of the effects of climate on primary production are reviewed and the consequences for fisheries production are evaluated through regional examples. Regional examples are also used to show changes in distribution and phenology of plankton and fish, which are attributed to climate. The role of discontinuous and extreme events (regime shifts, exceptional warm periods) is discussed. Changes in fish population processes can be investigated in experiments and by analysis of field data, particularly by assembling comparative data from regional examples. Although our existing knowledge is in many respects incomplete it nevertheless provides an adequate basis for improved management of fisheries and of marine ecosystems and for adapting to climate change. In order to adapt to changing climate, future monitoring and research must be closely linked to responsive, flexible and reflexive management systems.

Impacts of climate change on fisheries, Journal of Marine Systems, 79, 2010. (See [53](#)).



(3) Coastal Zones

Potential climate change impacts on coastal zones/areas to consider include:

- Sea level rise;
- Increased flood-frequency probabilities;
- Increased frequency of extreme weather events;
- Precipitation change;
- Higher summer temperatures;
- Coastal erosion;
- Inundation;
- Rising water tables;
- Saltwater intrusion; and
- Biological effects.

What Coastal Zone Managers Need to Know

In this study, "coastal management" is defined as all management occupations concerned with the safety, environmental protection, public infrastructure, and development of coastal areas, on land and in near shore coastal waters. To assure coastal states and communities are beginning to prepare, mitigate, and adapt adequately to the impacts of climate change, this information should (ideally) percolate from scientists to the managers who need it most. The information that is generally used in the coastal managers' daily work is about environmental features. Next category of information used is weather, than socioeconomic information and geologic information. Interviewees identified various information management needs and specific ways to make available information more accessible and user-friendly. As sources of information coastal managers scientific journals, professional journals, in-house colleague, professional literature, State agency staff etc. coastal managers also use maps, GIS, analytic models, forecast models, decision support tools and database management to display, analyze and/or transform available technical information into useful management relevant information. To date, coastal managers insufficiently benefit from the available scientific information on coastal impacts of climate variability and change and sea-level rise, as it exists in largely untapped scientific journals, few experts are ever consulted, and relevant research institutions are not yet linked into the "management on the ground." Moreover, coastal managers are interested in the topic and would be willing to address climate change impacts in their work, but they require financial and technical assistance from other agencies at the state and federal level or from one or more boundary organizations that can play the intermediary role of co-producing knowledge resources between science and management.

More than information see: What coastal managers need to plan for climate change, Environmental Science and Policy, 11, 2008. (See [28](#)).

These impacts may affect the following elements of coastal environment:

- Coral reefs;
- Coastal wetlands;
- Coastal fisheries;
- Mariculture;
- Recreation and tourism;
- Freshwater resources;
- Human settlements;
- Coastal infrastructure; and
- Human health; etc.

Climate Change Effects on Coastal Ecosystems

Coastal areas historically have been the preferred geography for human settlements and development, and coastal ecosystems are one of the most degraded natural systems because of this social trend. Climate change is forecasted to exacerbate current environmental degradation and further alter coastal landscapes, as coastal areas and ecosystems are some of the more vulnerable places to climate change. The guide proposes a 7-step process for considering potential impacts of climate change: Step 1: Identify conservation targets; Step 2: Identify key ecological attributes; Step 3: Identify existing non- climate stressors on key ecological attributes; Step 4: Identify projected climate stressors/ impacts; Step 5: Evaluate climate effects on conservation targets; Step 6: Identify long-term management goals and objectives; Step 7: Formulate a long- term management plan. Each step is described with an example, why the step is important, how to use it and helpful resources.

Office of Ocean and Coastal Resource Management Coastal and Estuarine Land Conservation Program: Voluntary Step-by-Step Guide for considering Potential Climate Change Effects on Coastal and Estuarine Land Conservation Projects, 2012. (See [41](#)).

The potential socio-economic effects of sea level rise are:

- Direct loss of economic, ecological, cultural and subsistence values through loss of land, infrastructure and coastal habitats.
- Increased flood risk to people, land and infrastructure and the values stated above.
- Other effects relating to changes in water management, salinity and biological activity, such as loss of tourism, loss of coastal habitats and effects on agriculture and aquaculture.



Economic Impacts of Sea Level Rise

The paper provides background information on the problem of sea level rise. Its contribution is threefold. First, it proposes a framework to discuss the economic growth impact of sea level rise. Second, it reviews the channels through which sea level rise can affect economic growth, namely the loss of land, the loss of infrastructure and physical capital, the loss of social capital, the additional cost from extreme events and coastal floods, and the increased expenditure for coastal protection. Finally, it discusses how existing studies on the direct impact of sea level rise could be used to investigate the resulting consequences on economic growth, emphasizes research needs on this question, and discusses consequences on migration. The main conclusion of this paper is that sizeable impacts of sea level rise on economic growth and welfare are possible, at least at the regional scale, even though it is difficult to quantify this effect with current knowledge.

A framework to investigate the economic growth impact of sea level rise, IOP Science, 2012. (See [64](#)).

Sea-level rise has a number of biophysical effects on coastal area including relevant interacting climate and non climate factors. Most of these impacts are broadly linear functions of sea-level rise, although some processes such as wetland loss and change show a threshold response and are more strongly related to the rate of sea-level rise, rather than the absolute change. The natural-system effects of sea-level rise have a range of potential socio-economic impacts, including the following:

- Increased loss of property and coastal habitats;
- Increased flood risk and potential loss of life;
- Damage to coastal protection works and other infrastructure;
- Loss of renewable and subsistence resources;
- Loss of tourism, recreation, and transportation functions;
- Loss of non-monetary cultural resources and values; and
- Impacts on agriculture and aquaculture through decline in soil and water quality.



Economic Impacts of Sea Level Rise

The paper starts with the hypothesis that coastal ecosystems, particularly intertidal wetlands and reefs (coral and shellfish), can play a critical role in reducing the vulnerability of coastal communities to rising seas and coastal hazards, through their multiple roles in wave attenuation, sediment capture, vertical accretion, erosion reduction and the mitigation of storm surge and debris movement. The paper describes the factors that affect the strength or efficacy of these ecosystem services in different locations, as well as management interventions, which may restore or enhance such values. The authors argue that improved understanding and application of such knowledge form a critical part of coastal adaptation planning, likely reducing the need for expensive engineering options in some locations, and providing a complementary tool in hybrid engineering design. Furthermore, they argue that irrespective of future climate change, coastal hazards already impact countless communities and the appropriate use of ecosystem-based adaptation strategies offers a valuable and effective tool for present-day management. Maintaining and enhancing coastal systems will also support the continued provision of other coastal services, including the provision of food and maintenance of coastal resource dependent livelihoods.

The role of ecosystems in coastal protection- Adapting to climate change and coastal hazards, Ocean and Coastal Management, In Press. (See [65](#)).

See Documents [2](#), [5](#), [8](#), [9](#), [10](#), [14](#), [15](#), [16](#), [18](#), [19](#), [26](#), [28](#), [35](#), [36](#), [37](#), [41](#) and [63](#) for more information.



3. References

References for Addressing Climate Change and Variability in GEF IW Marine Projects

Document typology key:

- Web portals (WP)
- Global Data Sources (DS)
- Policy guidance (PG)
- Practical guidance and tools (GT)
- Adaptation methodologies (AM)
- Training in climate change and adaptation (TR)
- Public/stakeholder involvement (SI)
- Ecosystem specific material
 - Open Oceans (OO)
 - Large Marine Ecosystems (LME)
 - Coastal Areas (CA)
 - Marine Resources (MR)
 - Sea Level Rise (SLR)

No.	Title	Source	Reference Typology	Location	Summary
1	Multidecadal Atlantic Climate Variability and its Impact on Marine Pelagic Communities	Journal of Marine Systems, In Press	OO	External Link	<ul style="list-style-type: none"> • AIMED AT: marine policy makers • PURPOSE: Effect of both natural climatic oscillations and recent Northern hemisphere-warming trend on sea surface temperature (SST) was investigated. The results were used to determine what drives the dominant behavior of various indicator species of plankton as well as plankton communities. • GEOGRAPHICAL AREA: North East Atlantic • TECHNICAL AREA: Understanding of the spatio-temporal influence of natural oscillations and climate change on sea surface temperature (STT) and the interaction with the ecology of the North East Atlantic, as described by various species of plankton • BASIC STRUCTURE: Spatio-temporal structure of the SST across the ocean basin scale explored. An understanding of the spatio-temporal structure of plankton abundance and its temporal drivers is of interest to marine policy makers because of the impact the plankton has on the rest of the marine ecosystem and to various industries such as fisheries. Even though there is a general trend towards rising temperatures, there are regions of the North Atlantic that have been cooling over the past few decades, as well as other regions that have been warming at a quicker rate. The reasons for this spatial heterogeneity comprise various physical features, such as bathymetry, currents and the positioning of high and low pressure centers. The Atlantic Multidecadal Oscillation (AMO) influences temperature changes across the North Atlantic but this influence is stronger where the effects of overturning ocean currents are particularly influential. The AMO may also have an impact on the occurrence of hurricanes in the Atlantic. Since it is thought to be connected to the circulation of the North Atlantic, the AMO might influence plankton abundance through changes in circulation rather than changes in temperature.
2	Introductory comments - Global change in marine ecosystems: Patterns, processes and interactions with regional and local scale impacts	Journal of Experimental Marine Biology and Ecology, 400, 2011	LME	External Link	<ul style="list-style-type: none"> • AIMED AT: Marine scientists • PURPOSE: Introduction to special issue. Combination of reviews, synoptic papers and new data papers on climate change issues in marine ecosystems. • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Fishing, pollution, sea level rise (SLR) • BASIC STRUCTURE: The volume is ordered into themes, the front end comprising review papers with a regional focus. The next section comprises long-term and broad-scale studies, beginning with two European synoptic review papers. The next section focuses on the individual level responses to global environmental change. The last section focuses on anticipating and adapting to global change.

No.	Title	Source	Reference Typology	Location	Summary
3	Impacts of climate change on European marine ecosystems: Observations, expectations and indicators	Journal of Experimental Marine Biology and Ecology, 400, 2011	LME	External Link	<ul style="list-style-type: none"> ● AIMED AT: Those who formulate adaptive strategies to address consequences of climate change ● PURPOSE: Paper summarizes the current state of knowledge with regard to general and region- specific impacts of climate change on 10 European marine systems. ● GEOGRAPHICAL AREA: Europe marine ecosystems ● TECHNICAL AREA: Marine changes due to climate change ● BASIC STRUCTURE: In general for the European Seas considered here the pattern of sea temperature over the last century has fluctuated from generally cold conditions in the early 1900s to a warm period from the 1920s to the 1950s, cool again through the 1960s and 1970s, followed by recent warming that commenced in the mid 1980s. Many marine species are moving northwards. The rate and direction differs for diverse seas and species. Enclosed seas, such as the Baltic, the Mediterranean and the Black Sea, have only small and primarily east-west orientated corridors, which may restrict northward migration in these areas. For most open seas, there is evidence of species moving northwards and/or northern species being replaced by more southern ones. Such changes not only affect the local ecosystems, but also the international fishing industry when commercial species such as cod are involved. It is expected that within open systems there will generally be northward movement, from polar to more temperate species in the more northern seas such as the Arctic, Barents Sea and the Nordic Seas and from temperate to more subtropical species in the southern seas such as the Iberian upwelling margin. It is expected that within open systems there will generally be northward movement, from polar to more temperate species in the more northern seas such as the Arctic, Barents Sea and the Nordic Seas and from temperate to more subtropical species in the southern seas such as the Iberian

No.	Title	Source	Reference Typology	Location	Summary
4	Can marine fisheries and aquaculture meet fish demand from a growing human population in a changing climate?	Global Environmental Change, 22, 2012	MR	External Link	<ul style="list-style-type: none"> • AIMED AT: Fisheries and aquaculture managers • PURPOSE: To assess whether global per capita consumption rates can be maintained or even increased in 2050, taking into account projections of human population growth and expected climate change • GEOGRAPHICAL AREA: World • TECHNICAL AREA: Fisheries and aquaculture • BASIC STRUCTURE: Paper concludes that marine ecosystems may be able to sustain current and increased per capita consumption rates through 2050, provided that effective fisheries management measures are implemented and that significant technological adaptations are developed. If fisheries management remain sub-optimal and fishmeal prices rose as a consequence of greater demand, these conclusions would not hold. It is predicted that there will be 6% overall increase on marine fisheries potential for "large" fish across the studied areas and a 3.6% increase on "small" fish in the top-twelve fishmeal producing nations. Conclusion is that in the case of capture fisheries, climate change impacts on production may not be the most significant factor in securing fish availability in the near future (to 2050). Ensuring that fisheries are efficiently governed and that aquaculture continues to grow in a sustainable manner will be the main constraints to the sustainability of global fish production. Policies encouraging improved environmental standards in aquaculture production and greater commitment to address governance weaknesses in capture fisheries will both be required.
5	Vulnerability of coastal communities to key impacts of climate change on coral reef fisheries	Global Environmental Change, 22, 2012	CA MR	External Link	<ul style="list-style-type: none"> • AIMED AT: Managers, donors and other policy-makers • PURPOSE: Paper examines three dimensions of vulnerability to the impacts of coral bleaching on fishery returns • GEOGRAPHICAL AREA: Indian Ocean countries • TECHNICAL AREA: Vulnerability of coral reefs to climate change • BASIC STRUCTURE: Local-scale actions over medium-term time frames (i.e. <5 years) can include strengthening community groups responsible for managing coastal resources, improvements in coastal infrastructure, and migration to non-coastal areas. In much of the western Indian Ocean, community-based organizations are increasingly empowered with the responsibility of managing coastal resources such as reef-based fisheries. In the short term, national scale efforts to provide social safety nets may help to increase adaptive capacity by preventing the marginally poor from falling into poverty traps and reduce exposure to climate change. International-scale policy actions are much more general, with little specificity to coral reefs. Effectively adapting to changes in coral reef fisheries will also require governance of broader marine seascapes. Decades of research on common property institutions have suggested that there is a clear need for governance rules to be congruent with local social and environmental conditions.

No.	Title	Source	Reference Typology	Location	Summary
6	Climate projections for selected large marine ecosystems	Journal of Marine Systems, 79, 2010	LME	External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers, government • PURPOSE: to analyze climate change and variability model results of physical properties relevant to LMEs • GEOGRAPHICAL AREA: regions of northwest Hawaii Islands, the Bering Sea, three eastern boundary currents regions, the Barents and the North Sea in the Atlantic • TECHNICAL AREA: climate change effects on marine ecosystems • BASIC STRUCTURE: Findings support the CMIP3 models as a useful source for climate projections on regional scales for marine ecosystem interests. Care must be exercised in their application with respect to selecting a reliable subset of models when extracting relevant variables in that not all models are equally reliable. Therefore, it is probably good practice to exclude models that clearly do not characterize a system properly to the extent this can be determined given limited data sets for validation. It is also a good idea to retain as many models as possible to form an ensemble forecast in order to reduce the errors intrinsic to individual models and provide important information on the uncertainty in these projections on the whole.
7	Rapid warming of Large Marine Ecosystems	Progress in Oceanography, 81, 2009	LME	External Link	<ul style="list-style-type: none"> • AIMED AT: Project development experts • PURPOSE: To study sea surface temperature (SST) change in the World Ocean in 1957–2006 period • GEOGRAPHICAL AREA: LMEs • TECHNICAL AREA: Warming of large marine ecosystems • BASIC STRUCTURE: The U.K. Meteorological Office Hadley Centre SST climatology was used to compute 50-year time series (1957–2006) of sea surface temperature (SST) and examine SST trends in the World Oceans' 63 LMEs. Reflecting a global trend, warming in most LMEs accelerated in late 1970s–early 1980s. Of the 63 LMEs, 61 warmed and only two cooled in 1982–2006. Linear SST trends for each LME show a distinct global pattern of rapid warming in three regions: around the Subarctic Gyre in the European Seas; and in the East Asian Seas. Decadal rates of SST warming in these three regions are 2–4 times the global mean rate. These estimates are rather conservative as numerous independent studies based on various data sets reveal even higher rates in the 1990s–2000s, up to 10–12 times the global mean rate. The Subarctic Gyre warming is likely caused by natural variability related to the North Atlantic Oscillation. The proximity of the European and East Asian Seas to major industrial/ population agglomerations suggests a possible direct anthropogenic effect. Freshwater runoff in the European and East Asian Seas likely plays a special role in modulating and exacerbating global warming effects on the regional scale.

No.	Title	Source	Reference Typology	Location	Summary
8	The moving boundaries of sea level change: Understanding the Origins of Geographic Variability	Oceanography, 24 (2) 2011	OO	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Project development experts • PURPOSE: Paper explores two effects of regional sea level change: ice sheets gain or loss, and water movements between the continents and oceans • GEOGRAPHICAL AREA: World oceans • TECHNICAL AREA: Regional sea level change; origins of climate variability • BASIC STRUCTURE: While globally averaged sea level rise provides an important integrated measure of changes in the Earth system, regional sea level changes have a more direct impact on society and provide greater information for scientists interested in the response of the planet to climate change. The impact on regional sea level observations most commonly associated with Glacial Isostatic Adjustment (GIA) is the uplift, or post-glacial rebound, of the crust near the centers of the former ice sheets. In any effort to analyze present-day observations of sea level change, it is important to understand and estimate the contaminating influence of the ongoing responses of Earth's land and ocean to the last ice age, or GIA. Most of the current focus in regard to the mass component of sea level changes concentrates on present-day contributors of water from the continents, specifically, mass loss from ice sheets and glaciers, changes in the hydrological cycle, impoundment of water behind dams, and others. Often, the impacts of these sources are reported in terms of global average sea level change calculated as the volume of water divided by the ocean's area.
9	Land Ice and Sea Level Rise: A Thirty-Year Perspective	Oceanography, 24 (2) 2011	SLR	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers • PURPOSE: To present perspective on the sea level rise caused by melting of glaciers • GEOGRAPHICAL AREA: Coastal areas worldwide • TECHNICAL AREA: Impacts of the sea level rise • BASIC STRUCTURE: The present-day assessment of contributions to sea level rise from glaciers and ice sheets depends to a large degree on new technologies that allow efficient and precise detection of change in otherwise inaccessible Polar Regions. The creation of an overall research strategy, however, was set in early collaborative efforts nearly 30 years ago to assess and project the contributions of glaciers and ice sheets to sea level rise. Many of the research objectives recommended by those early collaborations were followed by highly successful research programs and led to significant accomplishments. Over the last decade, when mass loss rates from Greenland and Antarctica started to accelerate, some means of projecting glacier and ice sheet changes became increasingly necessary, and alternatives to deterministic numerical models were sought. The result was a variety of extrapolation schemes that offer partial constraints on future glacier and ice sheet losses, but also contain significant uncertainties and rely on assumptions that are not always clearly expressed. This review examines the history of assessments of glacier and ice sheet contributions to sea level rise, and consider how questions asked 30 years ago shaped the nature of the research agenda being carried out today.

No.	Title	Source	Reference Typology	Location	Summary
10	Planning for the impacts of sea level rise	Oceanography, 24 (2) 2011	CA SLR	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers • PURPOSE: Focus is on adaptation to sea level rise, although some brief remarks on mitigation are included, as both strategies need to be combined to develop the most effective response to sea level rise. • GEOGRAPHICAL AREA: Coastal areas worldwide • TECHNICAL AREA: The concentration of population and assets, including many major cities, along the coasts; impacts of the sea level rise on these places • BASIC STRUCTURE: Over the twentieth century, global sea level rose about 17 cm. While this change may seem small, it will have many significant effects, most particularly in terms of reducing the return periods of extreme water levels and promoting an erosive tendency for coasts. There are significant actual and potential impacts of relative sea level rise in deltas and in and around subsiding coastal cities in terms of increased water logging, flooding, and submergence, and the resulting need for management response. Planning for sea level rise is a multidimensional problem that crosses many disciplines and embraces natural, social, and engineering sciences. Sea level rise has important implications for coasts worldwide, but the actual outcome will depend on our responses, both in terms of mitigation and adaptation, and their successes or failures. Coastal cities worldwide will be a major focus for adaptation efforts because of their concentrations of people and assets and given their concentration of people and assets, and their ability to fund large investments. Developing countries will pose adaptation challenges, especially in deltaic areas and small islands, which are the most vulnerable settings. The issues tackled in the paper include: (1) How to best plan for the threat of sea level rise and its implications? (2) What are the major responses are possible? (3) How to carry out adaptation and mitigation responses.
11	Understanding and projecting sea level change	Oceanography 24 (2), 2011	SLR CA	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers • PURPOSE: To make projections of sea level rise and identify challenges faced in making projections • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Sea level rise projections based on AR4 model of IPCC, global and challenges of making regional projections • BASIC STRUCTURE: Over the last decade, there has been significant progress in understanding of future sea level change and, as a result, confidence that global averaged sea level is rising and will continue to rise through the twenty-first century and beyond has increased. The amount of rise is dependent on future emissions of greenhouse gases. There are likely to be significant regional differences in the amount of sea level change from both ocean dynamic responses and changes in mass distribution, principally from a changing cryosphere. However, major deficiencies in our understanding remain, and current projections still cover a broad range of values regardless of emission scenarios. Perhaps the major challenge is the response of the ice sheets, particularly those parts grounded below sea level. A second set of challenges relates to better understanding of the regional distribution of sea level change, short-term prediction of sea levels, and the impacts of climate change on extreme events.

No.	Title	Source	Reference Typology	Location	Summary
12	Climate change impacts on the biophysics and economics of world fisheries	Nature Climate Change, 1, 2011	MR OO	External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers • PURPOSE: Document reviews existing knowledge on the responses of marine ecosystems to climate changes, and how these changes are expected to affect the economics of global marine fisheries, and describe approaches that can be used to adapt to these changes. • GEOGRAPHICAL AREA: Oceans and seas • TECHNICAL AREA: Climate change effects on fisheries • BASIC STRUCTURE: Marine fisheries catches consist almost solely of fishes and invertebrates — animals that are strongly dependent on oceanographic conditions. Theory and recent experimental evidence suggest that changes in temperature and ocean chemistry directly affect the physiology, growth and reproduction of these organisms. There is also evidence that ocean acidification and expansion of oxygen minimum zones may have negative impacts on marine organisms and fisheries, although their generality is uncertain. Changes in environmental conditions also strongly affect the spatial distributions of marine fishes and invertebrates. The economic consequences of climate change on fisheries might manifest themselves through changes in the price and value of catches, fishing costs, fishers' incomes, earnings to fishing companies, discount rates and economic rent (that is, the surplus after all costs, including 'normal' profits, have been covered), as well as throughout the global economy. Capital costs, that is, the cost of vessels, fishing gear, processing plants and so on, would be affected by climate change if additional capital for fishing and processing operations is required to adapt to climate change impacts on the quantity, composition and distribution of fisheries resources. Based on experience from historical responses of countries to fisheries changes, possible adaptation strategies include vessel buybacks, restricting the use of some gear types and livelihood diversification measures.

No.	Title	Source	Reference Typology	Location	Summary
13	The need for new ocean conservation strategies in a high-carbon dioxide world	Nature Climate Change, 2, 2012	OO LME	External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers • PURPOSE: To analyze possibilities for conservation strategies to preserve ocean biodiversity • GEOGRAPHICAL AREA: Oceans and LMEs • TECHNICAL AREA: Ocean biodiversity • BASIC STRUCTURE: The historically unprecedented threats to the marine environment posed by increasing atmospheric carbon dioxide will probably require the use of unconventional, non-passive methods to conserve marine ecosystems. Soliciting such approaches and evaluating their cost, safety and effectiveness must be part of a robust ocean conservation and management plan going forward. The paper advises that marine science and management communities should actively solicit and evaluate all potential marine management strategies, including unconventional ones, to determine which, if any, might satisfy the Convention on Biological Diversity's call for cost-effective prevention of environmental degradation. It proposes that it is best to implement such strategies only after they have been shown to be necessary, safe and effective, that is, the socio-economic and ecological costs and benefits have been assessed. It must also be acknowledged that short of stabilizing if not reducing atmospheric CO₂, there may ultimately be no perfect or even satisfactory conservation options for the ocean, either globally or regionally. The paper calls for: (1) the solicitation of new marine management and conservation methods; (2) the evaluation of their environmental, societal, and monetary cost effectiveness; and (3) policies that support the preceding.

No.	Title	Source	Reference Typology	Location	Summary
14	The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones	Environment and Urbanization, 19, 2007	CA	External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers • PURPOSE: The study integrates recently constructed, spatially explicit global databases and analyzes them to assess the distribution of population and settlement size in the low elevation coastal zone • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Urban settlements in low elevation coastal zones and populations that are at risk from sea-level rise • BASIC STRUCTURE: Many coastal populations are at risk from flooding – particularly when high tides combine with storm surges and/or high river flows. The estimates of global mean sea-level rise in the Special Report on Emissions Scenarios of the IPCC range from 22 centimetres to 34 centimetres, between 1990 and the 2080s. The risks to human settlements could be reduced if people and enterprises could be encouraged to move away from the coast, or at least from the most risk-prone coastal locations. Even as the seaward risks associated with climate change are increasing, the areas most at risk are experiencing particularly high population growth. There is considerable variation within regions and income categories, and there are a number of features that can lead a country to have a large share of its urban and rural populations in the Low Elevation Coastal Zone (LECZ). These include long coastlines (relative to the country's size), wide and heavily populated coastal lowlands, and sparsely populated interiors. Most of the countries with large populations in the LECZ are also among the most populous countries overall, with large Asian countries dominating. The countries with large shares of population (or urban population) in the LECZ are a more varied group, and include countries characterized by each of the three factors. Looking to the future, the responses to the growing risks to coastal settlements brought on by climate change should include mitigation, migration and modification.

No.	Title	Source	Reference Typology	Location	Summary
15	Benefits of mitigation of climate change for coastal areas	Global Environmental Change, 14, 2004	CA	External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers • PURPOSE: The paper explores the potential benefits of mitigation of human-induced climate change in coastal areas, with an emphasis on sea-level rise. Its goal is to provide a solid basis for future discussions on this important issue across the spectrum of the science of sea-level rise and climate change and its possible impacts. • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Mitigation of coastal change in coastal areas • BASIC STRUCTURE: The local change in sea level at any coastal location depends on the global mean sea-level rise and regional deviations from this mean. Acceleration of the global-mean rise trend during the 20th century is difficult to detect because of the limited number of gauges with long records and the long period natural variability measured at each gauge. Projections of future sea level need to include both the response to future emissions of greenhouse gases and the ongoing response to past emissions. This latter component is the commitment to sea-level rise and will continue for many centuries into the future, even if the concentration of greenhouse gases and aerosol particles in the atmosphere were stabilized immediately. Future sea-level rise can be estimated for different types of scenario using climate models of varying complexity. In addition to rising sea levels, future global climate change is expected to directly alter many other environmental factors. Mean temperatures are projected to increase around the globe. Mitigation will only significantly reduce the future rate and magnitude of sea-level rise after the middle of the 21st century and the largest benefits occur long into the future. Unmitigated impacts could be significant and are reduced to varying degrees by mitigation. Hence based on the available knowledge, a combination of mitigation and adaptation are required in coastal areas and both policies need to be assessed in an integrated manner to develop a response to climate change. Such assessment should also include the immediate benefits of adaptation in terms of the increased capacity to deal with climate variability.

No.	Title	Source	Reference Typology	Location	Summary
16	Climate Change Impacts on U.S. Coastal and Marine Ecosystems	Estuaries, 25 (2), 2002	CA LME MR	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers, scientists, project developers • PURPOSE: The paper explores the potential impacts of climate change on a number of coastal and marine ecosystems and resources and proposes adaptation and coping strategies for each ecosystem • GEOGRAPHICAL AREA: United States • TECHNICAL AREA: Climate change impacts on coastal areas and marine ecosystems • BASIC STRUCTURE: Increases in concentrations of greenhouse gases projected for the 21st century are expected to lead to increased mean global air and ocean temperatures. The paper is a summary of the NAST 2001 coastal and marine resources sector review of potential impacts on shorelines, estuaries, coastal wetlands, coral reefs, and ocean margin ecosystems. The assessment considered the impacts of several key drivers of climate change: sea level change; alterations in precipitation patterns and subsequent delivery of freshwater, nutrients, and sediment; increased ocean temperature; alterations in circulation patterns; changes in frequency and intensity of coastal storms; and increased levels of atmospheric CO₂. Increasing rates of sea-level rise and intensity and frequency of coastal storms and hurricanes over the next decades will increase threats to shorelines, wetlands, and coastal development. Estuarine productivity will change in response to alteration in the timing and amount of freshwater, nutrients, and sediment delivery. Higher water temperatures and changes in freshwater delivery will alter estuarine stratification, residence time, and eutrophication. Increased ocean temperatures are expected to increase coral bleaching and higher CO₂ levels may reduce coral calcification, making it more difficult for corals to recover from other disturbances, and inhibiting poleward shifts. Ocean warming is expected to cause poleward shifts in the ranges of many other organisms, including commercial species, and these shifts may have secondary effects on their predators and prey. Although these potential impacts of climate change and variability will vary from system to system, it is important to recognize that they will be superimposed upon, and in many cases intensify, other ecosystem stresses (pollution, harvesting, habitat destruction, invasive species, land and resource use, extreme natural events), which may lead to more significant consequences.

No.	Title	Source	Reference Typology	Location	Summary
17	Climate variability and marine ecosystem impacts: a North Atlantic perspective	Progress in Oceanography, 49, 2001	LME OO	External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers • PURPOSE: The paper reviews the findings and conclusion of studies, and relates the functions of various stocks of ground fish, pelagic and shellfish species in the North Atlantic to variability in marine climate • GEOGRAPHICAL AREA: North Atlantic • TECHNICAL AREA: Climate variability and its effects on fisheries and ecosystems • BASIC STRUCTURE: During the 20th Century, more especially during the past fifty years, major climatic variability in the North Atlantic has been attributed to long-term fluctuations in the North Atlantic Oscillation (NAO). Not only has there been decadal scale variation, but also a tendency for the NAO index to swing from extreme 'high' to 'low' over many decades. These trends in the NAO have coincided with substantial changes in marine ecosystems, particularly on fish productivity. The NAO fluctuations have had differential effects on the ecosystems of the different regions of the North Atlantic, and so vary from area to area. This study examined links between climate change and productivity in selected species such as: planktons, fish, shellfish, lobster, crab and shrimp. Recent changes in the range and upsurges in the productivity of certain invertebrate species have also been influenced by environmental forcing caused by this climatic variability. While broad trends throughout the North Atlantic are evident, the mechanisms are often unclear. More research is required to improve understanding of the impacts of climate variability upon the productivity of various components of marine ecosystems. More comprehensive studies of the interactions between productivity declines driven by climate variability and fishing are required.
18	Impacts of Climate Change on Marine Organisms and Ecosystems	Current Biology, 19, 2009	MR LME SLR	External Link	<ul style="list-style-type: none"> • AIMED AT: Scientists • PURPOSE: The paper describes present-day climate change, setting it in context with historical change, considers consequences of climate change for marine biological processes now and in to the future, and discusses contributions that marine systems could play in mitigating the impacts of global climate change. • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Threats to marine resources, sea level rise • BASIC STRUCTURE: Given the geographic variation in change in temperature, acidity and other factors, and the varying sensitivity of marine organisms and ecosystems, it is unlikely that any single strategy will alleviate impacts of climate change everywhere. A series of regionally-tailored response plans under local governance are required. However, on a global scale, an immediate reduction in CO2 emissions is essential to minimize future human-induced climate change. Improving models are increasing our ability to predict physical changes in the ocean that will impact marine and terrestrial biology, but we need to progress beyond prediction and monitoring of decline and act to halt degradation. Despite options for intervention, it may already be too late to avoid major irreversible changes to many marine ecosystems. As history has shown us, these changes in the ocean could have major consequences for the planet as a whole.

No.	Title	Source	Reference Typology	Location	Summary
19	Impacts of Climate Change on the European Marine and Coastal Environment Ecosystems Approach	European Science Foundation, 2007	CA LME	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers, future researchers • PURPOSE: The report summarizes the current state of knowledge with regard to general and regional-specific impacts of climate change on European marine and coastal environments, including climate variability • GEOGRAPHICAL AREA: European marine and coastal environment, including the Arctic, Northeast Atlantic, Barents Sea, Nordic seas, North Sea, Baltic Sea, Celtic-Biscay Shelf, Iberian upwelling margin, Mediterranean Sea, and Black Sea • TECHNICAL AREA: climate change impact on European marine and coastal environment • BASIC STRUCTURE: It is estimated that annual air temperatures will rise throughout Europe relative to recent conditions, with the lowest increase (1°C to 2°C) in the Mediterranean, Iberian, North Sea, Northeast Atlantic and south Nordic Sea regions (IPCC 2001). Temperature increases will be higher (4°C to 6°C) in the more northern regions such as the northern Nordic Seas and the Barents Sea, and highest (up to 7°C) in the Arctic. Precipitation and runoff will increase in northern Europe and the Arctic, but will decrease in warmer regions such as the Mediterranean. As temperatures rise, sea-ice coverage will decrease; most climate models suggest an ice free summer in the Arctic by 2100. The report identified specific recommendations on future monitoring and indicators and with regards to future research needs.
20	Frontline Observations on Climate Change and Sustainability of Large Marine Ecosystems	UNDP/GEF, Large Marine Ecosystems, Vol. 17, 2012	LME	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers, experts developing GEF projects • PURPOSE: to assist in development of GEF supported projects with a view of introducing the issue of climate change • GEOGRAPHICAL AREA: Benguela, Canary, Guinea, Agulhas and Somali, and Humboldt Currents LMEs; Bay of Bengal, Gulf of Mexico LMEs • TECHNICAL AREA: Climate change threats on large marine ecosystems • BASIC STRUCTURE: The role of the GEF in supporting LME projects, with a focus on the GEF's International Waters portfolio and the distribution of financial assistance to countries participating in LME sustainable development projects around the globe. Detailed analysis of climate change issues in LMEs. Special focus on acidification and impacts on marine resources

No.	Title	Source	Reference Typology	Location	Summary
21	Oceanic implications for climate change policy	Environmental Science and Policy, 9, 2006	OO	External Link	<ul style="list-style-type: none"> • AIMED AT: Policy-makers • PURPOSE: To show how the inclusion of the EEZ CO₂ sink within national carbon accounts would have significant implications in tracking national greenhouse commitments to any future climate change policy initiative • GEOGRAPHICAL AREA: Global, Pacific Ocean • TECHNICAL AREA: Significance of the exclusive economic zone CO₂ sink for inclusion within international climate policy • BASIC STRUCTURE: Historically it has been difficult to estimate the oceanic anthropogenic CO₂ sink. However there has been much progress over the last decade in measuring oceanic CO₂ and other properties to constrain the net oceanic CO₂ sink. As long as atmospheric CO₂ concentrations are increasing the ocean will attempt to equilibrate and in doing so will absorb a portion of this anthropogenically produced CO₂. The best example of a place where the gross natural ocean is a large source of CO₂, but represents a net sink for anthropogenic CO₂ is in the equatorial Pacific Ocean. The coastal ocean is an important part of the global carbon cycle and it will be important to further explore the CO₂ source/sink debate in the future. The policy analyses from this paper would extend to the coastal ocean, however it is far more difficult to determine the anthropogenic CO₂ uptake within this regime given its heterogeneous nature. There is no doubt however that human activities both on the adjacent coastal land and also within the open ocean could have the potential to change the EEZ anthropogenic CO₂ sink.
22	Adaptation in Europe Addressing risks and opportunities from climate change in the context of socio-economic developments	EEA, 2013	PG	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers • PURPOSE: This report draws on the experience of existing adaptation strategies and actions, promotes better informed decision-making in key vulnerable sectors and improved resilience across the EU. It supports the implementation of the EU Strategy on Adaptation to Climate Change. • GEOGRAPHICAL AREA: Europe • TECHNICAL AREA: Adaptations and actions responding to current and future climate change impacts and vulnerabilities • BASIC STRUCTURE: At EU level, the integration and mainstreaming of climate change in sectoral EU policies is the key policy 'lever' (areas where the EU has tools to act at its disposal) for advancing adaptation and alleviating pressures on human and natural systems. Integrated exercises assessing future consequences of climate change use tools and methods that incorporate assumptions and scenarios for both socio-economic developments and climate change variables (e.g. temperature, precipitation). Although the socio-economic variables are usually clearly differentiated from the climate change variables in terms of data inputs or assumptions, the majority of studies report their combined effect. There is no 'attribution' made to the role played by individual causes.

No.	Title	Source	Reference Typology	Location	Summary
23	Risk and Vulnerability Assessment Methodology Development Project (RiVAMP)	UNEP, 2010	WP CA	External Link	<ul style="list-style-type: none"> • AIMED AT: Technical experts • PURPOSE: Methodology developed to quantify the role of ecosystems for Disaster Risk Reduction (DRR), Climate Change Adaptation (CCA) as well as other benefits for sustainable development • GEOGRAPHICAL AREA: Latin America and the Caribbean, SIDS • TECHNICAL AREA: Coastal ecosystems, Coastal erosion, Climate change adaptation • BASIC STRUCTURE: The methodology is to show how ecosystems could be used for resilience against adverse impacts of natural hazards in a context of climate change. It was conceived to develop a methodology that takes into account environmental factors in the analysis of disaster risk and vulnerability. While different types of risk and vulnerability assessments are available, what is new about RiVAMP is that it recognizes ecosystems and climate change in the risk assessment process. The purpose of RiVAMP is to use evidence-based, scientific and qualitative research to demonstrate the role of ecosystems in disaster risk reduction, and thus enable policymakers to make better-informed decisions that support sustainable development through improved ecosystems management. In this regard, the targeted end-users of RiVAMP are national and local government decision makers, especially land use and spatial development planners, as well as key actors in natural resource management and disaster management. As a pilot initiative, the RiVAMP methodology is intended mainly for application in SIDS or coastal areas, and focuses on tropical cyclones and their secondary effects (coastal storm surges, flooding and strong winds). Accelerated sea level rise (ASLR) associated with climate change is also considered as an important factor contributing to risk of storm surges and beach erosion. The long-term view is to develop related methodologies under RiVAMP, which could be applied to other types of ecosystems, namely mountains, river basins and dry lands.

No.	Title	Source	Reference Typology	Location	Summary
24	Climate change mitigation and adaptation in strategic environmental assessment	EIA Review, Article in Press, 2011	GT	External Link	<ul style="list-style-type: none"> • AIMED AT: SEA practitioners • PURPOSE: The paper tests the hypothesis that SEA, when applied to spatial planning at regional and local levels, does not accommodate the CO2 reduction targets which are necessary for achieving the +2C limit, by determining what we might expect to see in any SEA considering climate change implications of a plan, in the sectors over which spatial planning has influence, and examining practice to see whether CO2 reduction targets are implemented. • GEOGRAPHICAL AREA: Regional and local level • TECHNICAL AREA: SEA, CO2 reduction, wider implication on coasts and oceans • BASIC STRUCTURE: Strategic Environmental Assessment is a particularly suitable instrument for the implementation of climate protection at the regional or local level, or in sectoral planning, such as transport planning. SEA can be seen as a real 'policy integration tool' to encourage greater attention in policy formation for climate change mitigation. SEA is a tool to assess the impacts on the environmental parameters listed in legislation, like soil, biodiversity, water etc. Methodological guidelines for devolving global climate protection targets down to the regional and local levels are necessary. Some first ideas about an operationalization and regionalization of targets have been made in this article. These guidelines should also contain concrete practical indications for the development of "climate friendlier" planning or programme alternatives, and for the development of avoidance, reduction and compensation measures, which ensure low climate impact.
25	A Framework for Assessing Climate Change Impacts on Water and Watershed Systems	Environmental Management, 43, 2009	GT	External Link	<ul style="list-style-type: none"> • AIMED AT: Water managers and decision makers • PURPOSE: The article presents framework for assessing climate change impacts on water and watershed systems to support management decision- making • GEOGRAPHICAL AREA: Non specified • TECHNICAL AREA: climate change impact on water and watershed systems, methodology could be extended to marine systems • BASIC STRUCTURE: Following steps provide a framework for assessing climate change impacts on water and watershed systems: Define the Decision Context, Develop conceptual model, Assess available climate data, Downscale climate data, Select impact assessment models, Conduct sensitivity analysis and scenario planning, Risk management (Adaptation). A case study assessment in Monocacy River (USA) watershed provides an example of how the framework can be applied. Results suggest the potential for significant impacts, and have resulted in follow-up work assessing climate change impacts for the entire Chesapeake Bay watershed, as well as extension of the Monocacy assessment to include consideration of coupled climate and land use change scenarios.

No.	Title	Source	Reference Typology	Location	Summary
26	An integrated spatial planning model for climate change adaptation in coastal zones	Ocean & Coastal Management, 66, 2012	GT CA SI AM	External Link	<ul style="list-style-type: none"> • AIMED AT: Experts • PURPOSE: The paper highlights the spatial planning approach for coastal sustainability and adaptation to climate change • GEOGRAPHICAL AREA: Taiwan • TECHNICAL AREA: Coastal Zone Management, spatial planning • BASIC STRUCTURE: An integrated spatial planning method, which balances the need and conflicting objectives of stakeholders while reflecting the dynamic changes in coastal systems produced by spatial planning solutions. This study has developed an optimization-stimulation model that is called Multi-Objective Programming and System Dynamic (MOPSD) to assist with spatial planning in coastal regions. One of its main goals is to mitigate the impact of climate change. MOPSD stimulates coastal area development under various spatial planning strategies that are based on the size of the coastal buffer zones. Decision makers are able to select optimal alternative within a dynamic environment for climate change adaptation in coastal zones. A case study of Chijin is shown where the MOPSD modeling approach generates superior solutions that each of the two traditional (MOP and SD) methods on their own. This is mainly attributed to the consideration of various deterministic and dynamic characteristics when evaluating the future of coastal regions.
27	Integrating knowledge to assess coastal vulnerability to sea-level rise: The development of the DIVA tool	Global Environmental Change, 19, 2009	CA GT SLR	External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers, experts • PURPOSE: The purpose of this paper is to present the process by which the integrated model was developed. • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Coastal zones, DIVA method, an interactive and modular method for assessing coastal vulnerability from sub-national to global levels • BASIC STRUCTURE: DIVA has been developed to meet the demand for new information on coastal vulnerability on a global scale, addressing important limitations of the earlier global studies. The DIVA method consists of two parts: a modeling framework and semi-automated development process. The DIVA method has been successfully applied to develop the DIVA tool. The DIVA tool comprises 4 main components: 1. A detailed global database with biophysical and socio-economic coastal data; 2. global and regionalized sea-level and socio-economic scenarios until the year 2100; 3. an integrated model, consisting of interacting modules that assess biophysical and socio-economic impacts and the potential effects and costs of adaptation; 4. a graphical user interface for selecting data and scenarios, running model simulations and analyzing the results.

No.	Title	Source	Reference Typology	Location	Summary
28	More than information: what coastal managers need to plan for climate change	Environmental Science and Policy, 11, 2008	PG CA SI AM	External Link	<ul style="list-style-type: none"> • AIMED AT: Local, regional, state and federal governments, coastal managers • PURPOSE: The information needs of California coastal managers area explored as they are confronting the growing risks for climate change. • GEOGRAPHICAL AREA: California, USA • TECHNICAL AREA: Specific information and knowledge coastal managers need to begin with when planning and preparing for adaptation to climate change • BASIC STRUCTURE: In this study, "coastal management" is defined as all management occupations concerned with the safety, environmental protection, public infrastructure, and development of coastal areas, on land and in near shore coastal waters. To assure coastal states and communities are beginning to prepare, mitigate, and adapt adequately to the impacts of climate change, this information should (ideally) percolate from scientists to the managers who need it most. The information that is generally used in the coastal managers' daily work is about environmental features. Next category of information used is weather, than socioeconomic information and geologic information. Interviewees identified various information management needs and specific ways to make available information more accessible and user-friendly. As sources of information coastal managers scientific journals, professional journals, in-house colleague, professional literature, State agency staff etc. coastal managers also use maps, GIS, analytic models, forecast models, decision support tools and database management to display, analyze and/or transform available technical information into useful management relevant information. To date, coastal managers insufficiently benefit from the available scientific information on coastal impacts of climate variability and change and sea-level rise, as it exists in largely untapped scientific journals, few experts are ever consulted, and relevant research institutions are not yet linked into the "management on the ground." Moreover, coastal managers are interested in the topic and would be willing to address climate change impacts in their work, but they require financial and technical assistance from other agencies at the state and federal level or from one or more boundary organizations that can play the intermediary role of co-producing knowledge resources between science and management.

No.	Title	Source	Reference Typology	Location	Summary
29	The Ocean and Climate Change Tools and Guidelines for Action	IUCN, 2009	OO GT MR	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Decision makers • PURPOSE: The purpose of this report is to engage, inform and guide decision makers with regard to the development and implementation of marine and coastal climate change strategies and programmes • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Interaction between ocean and climate, describes the impacts of climate change on the marine ecosystems and the goods and services they provide human society • BASIC STRUCTURE: The document provides an overview of the interactions between the ocean and climate and describes the impacts of climate change on the marine ecosystems and the goods and services they provide to human society. Further, it outlines a set of recommendations for marine-related mitigation and adaptation policy and implementation actions. The potential and limits of the ocean in climate change mitigation strategies is highlighted by sections on marine renewable energy resources, natural marine carbon sequestration, carbon capture and storage and ocean fertilization. The publication further stresses Ecosystem based Adaptation (EbA) as a means to improve social and ecosystem resilience to global ocean and climate change. Carefully designed marine protected areas and risk reduction management are included as means to reduce vulnerability of social and natural systems to future change.
30	Adaptation to Climate Change and Strategic Environmental Assessment	IMCORE	AM GT	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: SEA practitioners • PURPOSE: The objective of this report is to make an example if Strategic Environmental Assessment is a useful tool to facilitate decision-making in the light of climate change • GEOGRAPHICAL AREA: EU • TECHNICAL AREA: To integrate climate change in SEA • BASIC STRUCTURE: This report looks at possible entry points in the Strategic Environmental Assessment process to incorporate climate change impacts and adaptation considerations, from the screening phase that precedes the initiation of the Strategic Environmental Assessment, to the scoping and the environmental report, detailed assessment and implementation stages. Furthermore the report assesses if the integration of climate change is already a commonly used practice in the countries of North-West Europe and if it is recommended at international and European level. It concludes that Strategic Environmental Assessment can be a useful tool to address the problems and promote actions on adaptation to climate change into the planning process as well as to highlight possible adaptation conflicts with other existing regional/national plans and programmes.

No.	Title	Source	Reference Typology	Location	Summary
31	Strategic Environmental Assessment and Adaptation to Climate Change	OECD, 2010	GT AM	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: SEA practitioners • PURPOSE: To show how SEA approaches can help mainstream adaptation to climate change into strategic planning, in order to reduce the hazards, risks and vulnerabilities posed by climate change to systems and populations. • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Strategic Environmental Assessment (SEA) • BASIC STRUCTURE: A well-performed SEA can fulfill one or more of the following functions in relation to climate change adaptation: (i) an independent analysis of the likely performance of existing or new Policies, Plans or Programmes prepared without reference to climate change in light of new climate change predictions (effectively a form of climate proofing); (ii) an integrated planning and assessment process designed both to generate and test the response of PPP options to different climate scenarios, which are actively explored as part of the SEA; and (iii) a study process focusing entirely on predicting and quantifying the likely effects of climate change itself within a given area. The extent to which climate change considerations can be incorporated into an SEA, the level of detail required in the SEA process, and the relevance of the various questions outlined below, will depend on the entry point and the development activities and processes.
32	Toolkit for Integrating Climate Change Adaptation into Development Projects	CARE	WP AM	External Link	<ul style="list-style-type: none"> • AIMED AT: Practitioners • PURPOSE: The Toolkit offers practical, "how to" guidance for integrating climate change adaptation into the design, implementation, monitoring and evaluation of development projects. Its step-by-step structure helps users build climate-resilient projects with sustainable impacts. • GEOGRAPHICAL AREA: Africa, Asia, Latin America • TECHNICAL AREA: Development projects, mainstreaming • BASIC STRUCTURE: The Toolkit includes simple checklists to ensure that development activities don't increase people's vulnerability to climate change. It provides guidance and recommended tools for all stages of the project cycle, as well as tools, resources and practical examples from CARE projects around the world. Water resource management and agriculture projects are specifically highlighted, as they were targeted in the early tests of the Toolkit. This interactive Toolkit is designed to be flexible. Users can tailor the process to meet their needs, priorities and available resources. The Toolkit is designed to facilitate the integration of climate change adaptation into development projects. It is organized around the following, simplified stages in the project cycle: analysis, design and implementation. Information & knowledge management, including monitoring and evaluation, is treated as an ongoing function, which is integrated into each of these stages. For each stage in the project cycle, key issues are identified and step-by-step guidance is provided, as are recommended support tools and resources. Case studies and examples from field-testing the Toolkit on CARE projects in Africa, Asia and Latin America demonstrate how it can be used in practice.

No.	Title	Source	Reference Typology	Location	Summary
33	Integrating mitigation and adaptation into climate and development policy: three research questions	Environmental Science & Policy, 8, 2005	PG	External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers • PURPOSE: To provide guidance on how to develop a socially and economically justifiable mix of mitigation, adaptation and development policy, as well as on which elements would be part of such a mix. Moreover, research is needed to establish the conditions under which the process of mainstreaming can be most effective. • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Development projects, mainstreaming, mitigation and adaptation • BASIC STRUCTURE: For over a decade, climate policy has been largely synonymous with energy policy, with little attention being given to enhancing sinks or to adaptation. The international climate policy community is now becoming aware that energy policy alone will not suffice in the quest to control climate change and limit its impacts. Climate policy is being expanded to consider a wide range of options aimed at sequestering carbon in vegetation, oceans and geological formations and at reducing the vulnerability of sectors and communities to climate change impacts. Linkages between climate change and development are increasingly recognized. Climate change is largely the result of human-induced greenhouse gas emissions that are driven by socio-economic development patterns characterized by economic growth, technology, population and governance. These socio-economic development patterns, in turn, determine vulnerability to climate change and the human capacity for mitigation and adaptation. The impacts of climate change on human and natural systems in turn influence socio-economic development patterns and thereby greenhouse gas emissions.
34	Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment	EU, 2013	PG GT	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers • PURPOSE: The aim of this Guidance is to improve the consideration of these issues in strategic environmental assessments (SEAs) carried out across the EU Member States • GEOGRAPHICAL AREA: EU • TECHNICAL AREA: Biodiversity and SEA • BASIC STRUCTURE: The SEA Directive requires certain public Plans and Programmes to undergo an environmental assessment before they are adopted. Addressing climate change and biodiversity in the SEA process brings new challenges for the SEA practitioner. SEA should be used as an opportunity to address the key issues of climate change and biodiversity at an early stage, when many options are still open. SEA practitioners should outline climate scenarios that may either adversely affect implementation of the proposed Plans and Programmes or may worsen its impacts on biodiversity and other environmental factors. An analysis of alternatives is often viewed to be at the heart of the SEA process, as this provides confidence that the proposed course of action is the best one available. But there must be additional considerations of climate change and biodiversity issues if they are to be addressed effectively in SEAs.

No.	Title	Source	Reference Typology	Location	Summary
35	Adapting to climate variability and change: a guidance manual for development planning	USAID, 2007	GT CA	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Planners and stakeholders who cope with a changing climate • PURPOSE: The USAID Global Climate Change Team developed this Adaptation Guidance Manual to assist Missions and other partners to understand how climate change may affect their project outcomes and identify adaptation options to integrate into the design for more resilient projects. • GEOGRAPHICAL AREA: Developing countries • TECHNICAL AREA: Climate variability and change • BASIC STRUCTURE: This document presents the six-step approach for assessing vulnerability and identifying and implementing climate change adaptations (V&A approach) which follows a developmental path parallel to the more general project cycle. STEP 1 is to screen for vulnerability that involves screening a current or proposed project design to determine if it might be affected by climate variability or climate change. STEP 2 is to identify adaptation options for modifying the project in response to vulnerabilities identified by step 1. STEP 3 is to conduct analysis, implementing partners, stakeholders and experts to evaluate each of the adaptation options. The purpose of STEP 4 is to use the results from Step 3 to select one or more adaptations to be implemented with assistance from the project or program. STEP 5 are implement adaptations and STEP 6 is to evaluate adaptations.
36	Adapting to coastal climate change: A guidebook for development planners	USAID, 2009	PG GT CA OO	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Policymakers and practitioners • PURPOSE: Guidebook is both a tool in itself and a link to other resources to help with efforts to build resiliency against the impacts of climate change • GEOGRAPHIC AREA: coastal zones and world oceans (approx. 40% of worlds population) • THEMATIC AREA: Climate change and climate variability, mainstreaming, coastal management • BASIC STRUCTURE: The guidebook describes the 5-step process. Step 1: Assess vulnerability. The vulnerability assessment identifies numerous climate change risks and potential impacts to different sectors. Assessing a coastal area's vulnerability to the impacts of climate change involves understanding: 1) the climate projections for a given region or locale, 2) what is at risk (climate change exposure and sensitivity) and 3) the capacity of society to cope with the expected of actual climate changes (adaptive capacity). Step 2: Select course of action. The first thing in selecting a course of action is to identify the priority climate change risks upon which to focus efforts and resources. Step 3: Mainstream coastal adaptation. It is important to recognize that climate changes adaptation presents a fundamental challenge to managing the coastal resources and should be "mainstreamed" into coastal management and developed at all levels. Step 4: Implement adaptation. It is important to strengthen legal framework and enforcement as well as personnel capabilities. Step 5: Evaluate for adaptive management. All evaluations of coastal adaptation measures involve a similar methodology and steps. The steps of the evaluation include the following: Specify evaluation questions, elaborate an evaluation plan, conduct the evaluation and communicate the results.

No.	Title	Source	Reference Typology	Location	Summary
37	Climate Variability and Change and Sea-level Rise in the Pacific Islands Region A Resource Book for Policy and Decision Makers, Educators and other Stakeholders	SPREP	PG GT SLR SI	Download Here External Link	<ul style="list-style-type: none"> ● AIMED AT: Policy and decision makers, educators and other stakeholders ● PURPOSE: The Resource Book is designed to be used widely as a tool for awareness- raising, being a summary of the latest knowledge about climate change as it relates to the Pacific Islands region. ● GEOGRAPHICAL AREA: Pacific Islands region ● TECHNICAL AREA: Climate variability and change ● BASIC STRUCTURE: The Resource Book comprises four main sections, reflecting the four principal dimensions of the climate issue- the changing climate, the observed and potential impacts, and the two broad categories of policy responses and actions, namely mitigation and adaptation. Climate and Sea-level Variability and change in the mentioned area suggest that it will continue to be dominated by the inter-annual variability, due to the enhanced greenhouse effect the Region will likely be warm. Consequences of Climate and Sea-level Variability and Change in the Pacific Island Countries may include extensive coastal erosion, droughts, coral bleaching, more widespread and frequent occurrence of mosquito- borne diseases, and higher sea levels. Mitigation, as a response to Climate and Sea-level Variability and Change, in Pacific Island Countries is normally best implemented through a collaborative partnership involving at least some of the key players: developed countries, government, the private sector, community-based organizations, investors, donors and the public at large. Adaptation is other response. It requires enhancement of institutional capacity, developing expertise and building knowledge. It also needs an external entity to facilitate the adaptation process.

No.	Title	Source	Reference Typology	Location	Summary
38	Communicating climate change: history, challenges, process and future directions	WIRES, 1, 201	SI	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Public and policy makers • PURPOSE: The core of the paper focuses on key aspects of the communication process (purpose and scope of the communication, audience, framing, messages, messengers, modes and channels of communication, and assessing the outcomes and effectiveness of a communication). • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Communicating climate change • BASIC STRUCTURE: Today, after more than 20 years of scientific progress and a much greater scientific consensus, public climate change communication is no longer just a communication between experts. Thanks to media, it is now something that is discussed in general public. Concern, sense of urgency, and importance vary greatly across populations, and understanding of the causes and the stakes remains limited. The very purpose of climate change communication and audience choice are closely linked. The purpose of climate change communication is a critical first consideration. The second basic purpose of communication efforts is to achieve some type and level of social engagement and action. The third category of communication efforts aims even deeper by trying to foster not just political action or context-specific behavior modification, but to bring about changes in social norms and cultural values that act more broadly. If a particular communication goal has been set and an audience chosen, the way in which the climate change story is told is an inevitable element of communication, a powerful influence on how the audience is to interpret the information provided, and a strategically important choice. Frames construct a problem, provide a perspective from which to interpret it, even help us perceive some aspects of it, while disregarding or overlooking others, and deeply influence how persuasive we find the information being communicated. The message of climate change communication depends on who the audience is, who conveys the message, the channel through which a message is being conveyed; the place and context in which audiences receive the information, how they are likely to process the message received, the goals of the communication. But despite this context- dependency, some general guidelines can be provided. Messengers are integral aspects of the framing; they are also critically important in establishing the credibility of the information conveyed.

No.	Title	Source	Reference Typology	Location	Summary
39	Development and Climate Change: A Mainstreaming Approach for Assessing Economic, Social, and Environmental Impacts of Adaptation Measures				<ul style="list-style-type: none"> • AIMED AT: Policy makers • PURPOSE: The objective of this paper is to introduce how a mainstreaming approach can be operationalized • GEOGRAPHICAL AREA: Mozambique and Tanzania • TECHNICAL AREA: Definition of and a approach to mainstreaming • BASIC STRUCTURE: The idea of the mainstreaming approach is to assess climate change impacts and vulnerabilities in the context of development. In a more simple way it can be said that the aim of mainstreaming assessments is to ensure that current, as well as future development policies, are well adapted to the climate and this can imply that some adaptation options are recommended. This way the mainstreaming approach aims at assessing the relationship between the climate and development in general, without giving specific consideration to distinguishing anthropogenic climate change impacts and vulnerabilities from climate vulnerability of development policies, per se. A step-wise mainstreaming approach for assessing adaptation can include 5 analytical elements: Element 1: Climate Conditions, Variability and Future Changes; Element 2: Selection of Development Indicators; Element 3: Assessing the Relationship between Climate Variables and Development Indicators related to Specific Activities; Element 4: Adaptation options; and Element 5: Assessment of adaptation options, in order to measure the costs and development impacts of implementing these options.

No.	Title	Source	Reference Typology	Location	Summary
40	Guide to Considering Climate Change in Environmental Assessments in Nova Scotia	EcoAdapt, 2011	GT	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Project proponents • PURPOSE: The intent of this Guide is to assist project proponents in determining if the consideration of climate change would be beneficial to their project and how and where to incorporate climate change in a project's EA. • GEOGRAPHICAL AREA: Nova Scotia, Canada • TECHNICAL AREA: Climate change in environmental assessment • BASIC STRUCTURE: For each environmental assessment component, this Guide provides succinct advice on how to address climate change considerations. The Project Description will include information relevant to assessing the environmental impact of a project. Climate change considerations can be readily incorporated into these elements. The Existing Environment section of the EA will already include information on the local climate and meteorology in the vicinity of the project site. But, it can also include a summary of climate change projections for the project location where available. Specific consideration of climate change should be added to Issue Scoping. The scoping process should specifically consider whether or not climate change could impact the environmental concerns. Valued Environmental Components list will not be substantially affected by incorporating climate change. Climate change does not significantly alter the way in which proponent will conduct the impact assessment. The determination of the Significant Impacts and how these are defined does not change. However, if through the preceding steps of the EA, the project impacts in combination with climate change impacts on a VEC are evident then the proponent/practitioner should assess and discuss whether the significance of the combined impact increases or decreases the significance. Effects of the Environment on the Project is the most appropriate section for the assessment of climate change impacts on the project and to identify those components of the project that are vulnerable to climate change. Mitigation in EA refers to both measures to be taken to reduce GHG emissions; and measures to be taken to make the project less vulnerable to climate change. In addition, the mitigation section of the EA should describe what measures the proponent will take to reduce the significance of the identified combined project climate change impacts on climate sensitive VECs.

No.	Title	Source	Reference Typology	Location	Summary
41	Voluntary Step-by-Step Guide for considering Potential Climate Change Effects on Coastal and Estuarine Land Conservation Projects	Office of Ocean and Coastal Resource Management Coastal and Estuarine Land Conservation Program, 2012	GT CA	Download Here	<ul style="list-style-type: none"> • AIMED AT: Project applicants • PURPOSE: To assist experts to consider potential climate change impacts • GEOGRAPHICAL AREA: US • TECHNICAL AREA: Coasts, conservation, estuaries • BASIC STRUCTURE: Coastal areas historically have been the preferred geography for human settlements and development, and coastal ecosystems are one of the most degraded natural systems because of this social trend. Climate change is forecasted to exacerbate current environmental degradation and further alter coastal landscapes, as coastal areas and ecosystems are some of the more vulnerable places to climate change. The guide proposes a 7-step process for considering potential impacts of climate change: Step 1: Identify conservation targets; Step 2: Identify key ecological attributes; Step 3: Identify existing non-climate stressors on key ecological attributes; Step 4: Identify projected climate stressors/impacts; Step 5: Evaluate climate effects on conservation targets; Step 6: Identify long-term management goals and objectives; Step 7: Formulate a long-term management plan. Each step is described with an example, why the step is important, how to use it and helpful resources.
42	Integrating disaster risk management into climate change adaptation	ADPC, 2013	AM	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Disaster Risk management practitioner: specifically those DRM practitioners who are government officials and have the role of responsibility to manage or reduce disaster risks • PURPOSE: The handbooks aims to provide advice to the DRM practitioner on both strategic and practical options for operational implementation of DRM within a selection of development processes and tools. • GEOGRAPHICAL AREA: Asia and the Pacific • TECHNICAL AREA: Integrating Disaster Risk Management into climate change adaptation • BASIC STRUCTURE: Managing climate-related disaster risks includes preparation for extreme events and climate variability potentially arising out of climate changes. DRM and CCA have very similar aims in terms of promoting resilience in the face of hazards. They both focus on reducing vulnerability by improving the ways to anticipate, cope with and recover from their impacts. However, DRM and CCA are not the same as each field has its own concerns, with DRM looking to manage risks from all hazards and CCA looking to help societal systems and undertakings adapt to a changing climate. DRM tends to be looked after by civil defense authorities, while CCA tends to be looked after by ministries of environment. The two fields overlap in a common area, as both are concerned reducing vulnerability, with monitoring climate-related hazards and reducing exposure to these, and raising societal capacities to manage climate risks.

No.	Title	Source	Reference Typology	Location	Summary
43	Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners	Canadian Environmental Assessment Agency	WP GT	External Link	<ul style="list-style-type: none"> • AIMED AT: EA practitioners • PURPOSE: The purpose of this document is to provide environmental assessment (EA) practitioners with general guidance for incorporating climate change considerations in project EA • GEOGRAPHICAL AREA: Canada • TECHNICAL AREA: Environmental Assessment • BASIC STRUCTURE: The document provides general guidance, to be considered at the discretion of jurisdictions and regulatory authorities and includes: methods that can be used to obtain and evaluate information concerning a project's greenhouse gas (GHG) emissions and the impacts of climate change on a project; key sources of information that practitioners can use to address climate change considerations in project EA; and methodology to encourage the consistent consideration of climate change in the EA process across federal, provincial and territorial jurisdictions and institutions of public government responsible for EA.
44	Integrating Climate Change Adaptation into Development Co-operation: Policy Guidance	OECD, 2012	PG GT AM	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: sectoral Ministries, local governments, project planners and donor agencies • PURPOSE: This policy guidance is intended to provide policy makers and practitioners in development co-operation agencies with information and advice on how to mainstream climate change into development. • GEOGRAPHICAL AREAS: Global • TECHNICAL AREAS: Climate change adaptation, development co-operation • BASIC STRUCTURE: Implementing and "mainstreaming" adaptation is the approach of this policy guidance. While in certain situations stand-alone adaptation measure will be needed – for example to partially drain a potentially dangerous glacial lake - in most other cases adaptation measures will need to be implemented as part of a broader suite of measures within existing development processes and decision cycles. This is known as "mainstreaming". This policy guidance takes an integrated or "whole of government" approach to adaptation. Specifically, four levels of governance are examined: centralized national ministries and decision processes at the national level; sectoral ministries; project level; and the local level which includes both urban and rural contexts.

No.	Title	Source	Reference Typology	Location	Summary
45	Mainstreaming climate change adaptation in developing countries	UN, IIED, 2003	PG GT SI CA	Download Here	<ul style="list-style-type: none"> • AIMED AT: Policy makers in least developed countries • PURPOSE: The document provides examples and ways forward on how the least developed countries can mainstream the adaptation to climate change in their ongoing national development priorities. • GEOGRAPHICAL AREA: Least developed countries, Bangladesh, Mali • TECHNICAL AREA: Mainstreaming the adaptation to climate change in least development countries • BASIC STRUCTURE: The LDCs have contributed least to the emission of greenhouse gases, but they are the most vulnerable countries to the effects of climate change and they have least capacity to adapt to these changes. This report studies the experience of two LDC countries: Mali and Bangladesh. Mainstreaming adaptation in Bangladesh touches upon, among other, major project on integrated Coastal Zone Management, which allowed involved project managers to readily see the utility of incorporating climate change issues into their programming and planning. Efforts made to mainstream adaptation to climate change into national planning and activities in different sectors in Mali have been relatively successful for the agricultural sector, which already has a long history of working on drought prone agriculture. In the area of energy it was moderately successful. However, in other sectors (such as water resources) and at the national policy-making and planning levels, it has been less successful.
46	Mainstreaming climate change adaptation in developing countries	IDS, 2006	PG GT	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: National governments and donors • PURPOSE: The report intends to promote discussion on opportunities for further action research and on strategies for increasing awareness and information related to climate adaptation in development sectors. • GEOGRAPHICAL AREA: Pacific islands, Caribbean countries • TECHNICAL AREA: Mainstreaming climate adaptation • BASIC STRUCTURE: Developing countries, despite having contributed least to greenhouse gas emissions, are likely to be the most affected by climate change because they lack the institutional, economic and financial capacity to cope with the multiple impacts. Within developing countries, not all groups are affected equally. There are now a wide range of frameworks or instruments available to assess climate change impacts and options for adaptation. These include specific tools for assessment in specific sectors or regional context, as well as broader policy instruments that consider mainstreaming of adaptation responses such as Guidelines for the Preparation of National Adaptation Programmes of Action (NAPA), prepared through the UNFCCC process and the Adaptation Policy Framework (APF). In developed countries, progress has been limited on mainstreaming climate adaptation. Programs to reduce climate risk have been identified and there is a consensus that actions need to be taken to reduce these risks. But, most developing countries are still in the very early stages of identifying appropriate responses to climate change risks, limiting practical experience of mainstreaming climate change adaptation into national development planning. The documents provides recommendations to countries to improve mainstreaming of climate change into development projects.

No.	Title	Source	Reference Typology	Location	Summary
47	Mainstreaming Climate Change Adaptation: A Practitioner's Handbook	CARE, 2009	GT AM	Download Here External Link	<ul style="list-style-type: none"> ● AIMED AT: This handbook is primarily designed for CARE in Vietnam programme management (programme managers, component managers, project staff and programme officers) and project partners working at the district and commune level, but may prove useful to other development NGOs ● PURPOSE: The handbook will assist in analyzing the implications of climate change for the lives and livelihoods of the communities CARE work with ● GEOGRAPHICAL AREA: Vietnam with implications for other countries ● TECHNICAL AREA: Mainstreaming climate change into projects ● BASIC STRUCTURE: The handbook provides: methodology; practical tools; case studies; guidance and relevant information on how to assess project and program vulnerability to climate variability and change; and how to design and adapt projects so that they are more resilient to a range of climate change scenarios. Mainstreaming climate change adaptation is described as a process of considering climate risks to development projects, and of adjusting project activities and approaches to address these risks. Mainstreaming climate change adaptation can achieve three main objectives: (i) reducing the risks posed by climate change to project activities, stakeholders, and results, sometimes referred to as 'climate-proofing'; and (ii) ensuring that project or program activities maximize their contribution to adaptive capacity of target populations; and (iii) do not inadvertently increase vulnerability to climate change. The seven-step approach for mainstreaming climate change adaptation at the operational level, known as the Climate Vulnerability and Adaptation Pathway (CVA Pathway), is proposed. It follows a development path parallel to the project cycle. Step 1: Assess project activities for climate risk, Step 2: Decide on the CVA Pathway, Step 3: identify Adaptation Measures, Step 4: Prioritize Adaptation Measures, Step 5: Select Adaptation Option(s) for Implementation, Step 6: Implement Adaptation Measures, Step 7: Evaluate Adaptation and the CVA Pathway.

No.	Title	Source	Reference Typology	Location	Summary
48	Guide to the Integration of Climate Change Adaptation into the Environmental Impact Assessment (EIA) Process	SPREP, World Bank, GEF, CIDA, 2004	GT	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Practitioners • PURPOSE: To assist CARICOM and SPREP country practitioners with the integration of climate change adaptation considerations into the environmental impact assessment (EIA) process • GEOGRAPHICAL AREA: Caribbean and South Pacific Region • TECHNICAL AREA: Environmental Assessment, Climate change adaptation • BASIC STRUCTURE: The Guide does not propose to establish a new or parallel EIA process but rather identifies a few simple steps to be taken when utilizing existing EIA processes and procedures. It states that the EIA process should: a) evaluate a project's potential environmental risks and impacts in its area of influence; b) identify and evaluate potential impacts from climate change on the project's area of influence; c) examine project alternatives; d) identify ways of improving project selection, siting, planning, design, and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and anticipated adverse impacts from climate change, and enhancing positive impacts; and e) include the process of managing and adapting to adverse environmental impacts and anticipated adverse impacts from climate change throughout project implementation.
49	Mainstreaming climate change adaptation into development planning	SEI, 2012	PG	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers • PURPOSE: The report reviews the main approaches proposed and lessons learned from relevant experiences in the Asia-Pacific Region • GEOGRAPHICAL AREA: Asia-Pacific Region • THEMATIC AREA: Mainstreaming adaptation into development planning • BASIC STRUCTURE: The expected benefits of mainstreaming climate change adaptation into development activities include avoided policy conflicts; reduced risks and vulnerability; greater efficiency compared to managing adaptation separately, and leveraging the much larger financial flows in sectors affected by climate risks that the amounts available for financing adaptation separately. Mainstreaming adaptation into development planning will need to consider at least national, sectoral and sub-national levels. Several guides and frameworks have been proposed on how to integrate climate change concerns into ongoing national development processes: four-step framework for mainstreaming at national level, framework with three main components: 1) finding the entry points and making the case, 2) mainstreaming adaptation into policy processes, and 3) meeting the implementation challenge. The third framework was developed by OECD and was comprehensive and oriented towards national policy and planning systems and it is very complex.

No.	Title	Source	Reference Typology	Location	Summary
50	Strategic Environmental Assessment and Climate Change: Guidance for Practitioners	USEPA, 2004	PG GT	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: SEA practitioners • PURPOSE: This leaflet explains how climate change issues can be considered in strategic environmental assessment (SEA), with particular reference to the requirements of European SEA Directive • GEOGRAPHICAL AREA: EU • TECHNICAL AREA: Climate change, SEA • BASIC STRUCTURE: The SEA Directive requires authorities to assess the likely significant effects of their plans and programmes on "the environment, including on issues such as biodiversity, population, human health, fauna, flora, soil, water, air, climatic factors, material assets, cultural heritage including architectural and archaeological heritage, landscape and the interrelationship between the above factors". The document states that climate change needs to be considered at various stages of the SEA process.
51	Incorporating Climate Change Impacts and Adaptation in Environmental Impact Assessments Opportunities and Challenges	OECD, 2011	PG	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Policy Makers • PURPOSE: The paper provides an overview of the key steps in an Environmental Impact Assessment process and identifies potential entry points for incorporating information on climate change impacts. • GEOGRAPHICAL AREA: Global, Netherlands, Canada, Australia • THEMATIC AREA: EIA, climate change integration • BASIC STRUCTURE: Existing initiatives are based on a three-level framework that starts with an analysis of broad trends and becomes progressively more specific. First level is intentions. Among the developed countries Canada is probably furthest along in terms of recognition of climate change considerations within the context of EIA. The incorporation of climate change impacts is a requirement of the EIA process for major development projects. Level two is operational guidance and adjustment of legal and regulatory frameworks. Level 3 is implementation. Three countries are taken as an example (Netherlands, Canada and Australia) who already have some level of integration of climate change adaptation in their EIA legal framework.

No.	Title	Source	Reference Typology	Location	Summary
52	Mainstreaming Climate Change Adaptation in the Pacific: A Practical Guide	SPREP and UNDP, 2013	GT	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Country practitioners, regional governments and organizations, development partners • PURPOSE: The guide aims to provide a practical step-by-step framework on how to mainstream climate change into Pacific island countries and territories development planning and decision-making processes • GEOGRAPHICAL AREA: Pacific island countries • TECHNICAL AREA: Climate change adaptation, mainstreaming • BASIC STRUCTURE: The Pacific Adaptation to Climate Change (PACC) project has put together this guide as a response to the need from PACC-participating countries to integrate climate change risks into their national and sector strategies and plans, and budgetary processes. The recommended approach combines standard policy cycles commonly used in the Pacific with analytical inputs from the climate risk management (CRM) framework. This forms a seven-phase process representing a broad outline of how to mainstream climate risk into development planning and policy processes, with analytical inputs, outputs and key decisions described for each step. Steps include: preparatory activities; situation analysis; problem analysis; solution analysis; design of the outputs; implementation, monitoring and evaluation; and review. The guide operates at two levels: strategic level mainstreaming, and "on the ground" level mainstreaming. The process is illustrated with detailed case studies drawn from the region.

No.	Title	Source	Reference Typology	Location	Summary
53	Impacts of climate change on fisheries	Journal of Marine Systems, 79, 2010	MR LME	External Link	<ul style="list-style-type: none"> • AIMED AT: Fisheries experts • PURPOSE: The main aim of the paper is to assemble and analyze evidence of effects of climate on fisheries in order to (i) show that climate affects the distribution, productivity and resilience of fish stocks, (ii) develop understanding of the processes, and (iii) draw lessons from past experience • GEOGRAPHICAL AREA: Global, North Atlantic, Tropical Pacific, Tanzania, North Sea, Baltic • TECHNICAL AREA: Fisheries, climate change and variability, marine ecosystems • BASIC STRUCTURE: Evidence of the impacts of anthropogenic climate change on marine ecosystems is accumulating, but must be evaluated in the context of the "normal" climate cycles and variability which have caused fluctuations in fisheries throughout human history. The impacts on fisheries are due to a variety of direct and indirect effects of a number of physical and chemical factors, which include temperature, winds, vertical mixing, salinity, oxygen, pH and others. The direct effects act on the physiology, development rates, reproduction, behaviour and survival of individuals and can in some cases be studied experimentally and in controlled conditions. Indirect effects act via ecosystem processes and changes in the production of food or abundance of competitors, predators and pathogens. Recent studies of the effects of climate on primary production are reviewed and the consequences for fisheries production are evaluated through regional examples. Regional examples are also used to show changes in distribution and phenology of plankton and fish, which are attributed to climate. The role of discontinuous and extreme events (regime shifts, exceptional warm periods) is discussed. Changes in fish population processes can be investigated in experiments and by analysis of field data, particularly by assembling comparative data from regional examples. Although our existing knowledge is in many respects incomplete it nevertheless provides an adequate basis for improved management of fisheries and of marine ecosystems and for adapting to climate change. In order to adapt to changing climate, future monitoring and research must be closely linked to responsive, flexible and reflexive management systems.

No.	Title	Source	Reference Typology	Location	Summary
54	Climate Change Impacts on Marine Ecosystems	Annual Review of Marine Science, 4, 2012	LME	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Marine scientists • PURPOSE: To identify major impacts of climate change on marine resources • GEOGRAPHICAL AREA: US • TECHNICAL AREA: LMEs, climate and global change, coral reefs, polar systems • BASIC STRUCTURE: In marine ecosystems, rising atmospheric CO₂ and climate change are associated with concurrent shifts in temperature, circulation, stratification, nutrient input, oxygen content, and ocean acidification, with potentially wide-ranging biological effects. Population-level shifts are occurring because of physiological intolerance to new environments, altered dispersal patterns, and changes in species interactions. Together with local climate-driven invasion and extinction, these processes result in altered community structure and diversity, including possible emergence of novel ecosystems. Impacts are particularly striking for the poles and the tropics, because of the sensitivity of polar ecosystems to sea-ice retreat and poleward species migrations as well as the sensitivity of coral-algal symbiosis to minor increases in temperature. Mid-altitude upwelling systems, like the California Current, exhibit strong linkages between climate and species distributions, phenology, and demography. Aggregated effects may modify energy and material flows as well as biogeochemical cycles, eventually impacting the overall ecosystem functioning and services upon which people and societies depend.
55	Mainstreaming climate change adaptation into development planning: A Guide for Practitioners	UNDP-UNEP Poverty-Environment Initiative, 2011	PG GT	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Practitioners engaged in mainstreaming activities • PURPOSE: To provide practical, step-by-step guidance on how governments and other national actors can mainstream climate change adaptation into national development planning as part of broader mainstreaming efforts • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Mainstreaming, climate change adaptation, poverty alleviation • BASIC STRUCTURE: The framework proposed here consists of three components, each of which involves a set of activities or modules for which a range of tactics, methodologies and tools can be used: (i) Finding the entry points and making the case is concerned with setting the stage for mainstreaming. It involves understanding the linkages between climate change and national development priorities and understanding the governmental, institutional and political contexts that inform efforts to define pro-poor adaptation outcomes, find entry points into development planning, and make the case for adaptation mainstreaming; (ii) Mainstreaming adaptation into policy processes focuses on integrating climate change adaptation issues into an ongoing policy process, such as a national development plan or sector strategy, based on country-specific evidence (i.e., impact, vulnerability and adaptation assessments, socio-economic analysis and demonstration projects); and (iii) Meeting the implementation challenge aims at ensuring mainstreaming of climate change adaptation into budgeting and financing, implementation and monitoring, and the establishment of mainstreaming as standard practice. Stakeholder engagement occurs throughout, from inception through policy development, implementation and monitoring.

No.	Title	Source	Reference Typology	Location	Summary
56	Mainstreaming climate policy and policy coherence: A background report for the compiling of the foresight report of Vanhanen's second government	Prime Minister's Office Finland, 2009	PG	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers • PURPOSE: To review the main challenges to mainstreaming climate policy and policy coherence and to evince new ways of strengthening Finland's climate policy • GEOGRAPHICAL AREA: Finland • TECHNICAL AREA: Mainstreaming, climate change adaptation • BASIC STRUCTURE: The report describes issues related to the mainstreaming of climate policy from the perspectives of both horizontal and vertical integration and brings together examples of the measures of other countries. In light of these, the report makes recommendations as to how mainstreaming and policy coherence can be enhanced. Initially mainstreaming and policy coherence can be enhanced by further developing the existing administrative processes and structures and creating new measures focusing specifically on the mainstreaming of climate change. Here we present the main recommendations of our report.
57	Portfolio screening to support the mainstreaming of adaptation to climate change into development assistance	Tyndall Centre, 2007	PG	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers • PURPOSE: To respond to the need to mainstream adaptation to climate change into development planning and ongoing sectoral decision • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Mainstreaming, climate change • BASIC STRUCTURE: The paper assesses the screening of the development agencies' project portfolios activities to date, focusing on both the results and the methods applied. Based on this assessment the paper identifies opportunities for development agencies to expand their current focus on the links between climate and development. Most agencies already consider climate change as a real but uncertain threat to future development, but they have given less thought to how different development patterns might affect vulnerability to climate change. The screenings undertaken have shown the need to take a comprehensive approach to adaptation and its integration into development planning and sectoral decision-making, and a number of policy initiatives have been taken to promote such integration. The paper provides some initial guidance as to how portfolio screening can be carried out in a way that would allow agencies to assess systematically the relevance of climate change to their ongoing and planned development projects.

No.	Title	Source	Reference Typology	Location	Summary
58	Screening Tools and Guidelines to Support the Mainstreaming of Climate Change Adaptation into Development Assistance – A Stocktaking Report	UNDP, 2010	PG GT	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Policy Makers • PURPOSE: To take stock of the climate risk screening tools, mainstreaming guidelines, and portfolio screening experience from the donor community • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Mainstreaming, climate changes • BASIC STRUCTURE: The report explores the rationale for mainstreaming, outlines the main components necessary to operationalize mainstreaming, and indicates the various relevant levels and associated entry points to consider in the mainstreaming process. After this, it discusses and illustrates how key climate change adaptation and mainstreaming concepts are defined and used – both in relevant literature and in practice – as well as how they relate to development. It then focuses on climate risk screening methods tools and guidance and explores how climate risk screening efforts can be categorized in relation to mainstreaming, plus the components of mainstreaming that are addressed in the variety of climate risk screening tools and guidance. Finally, it provides a comparative overview and analysis of climate risk screening tools and guidance.
59	The challenges of environmental mainstreaming into development institutions and decisions	IIED, 2009	PG GT	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Policy Makers • PURPOSE: To develop a guide to a range of approaches and tools/methods for environmental mainstreaming applied at different levels (e.g. national, district, community) and by a range of users, and to identify which approaches and tools work best, for what purpose and for which user • GEOGRAPHICAL AREA: Caribbean, Chile, Croatia, Czech Republic, Ghana, India, Kenya, Uganda, Philippines, South Africa • TECHNICAL AREA: Mainstreaming, climate change, development • BASIC STRUCTURE: The paper reviews the context and challenges to environmental mainstreaming (EM), discusses what it takes to achieve effective EM, and provides a roadmap for selecting operational EM methods and tools. The focus is on those approaches and tools which directly help to shape policies, plans and decisions not the wider array of secondary tools applied to implement those decisions. The conclusion is that too many tools are being 'pushed' by outside interests, and too few locally developed (and more informal, or less expensive) approaches are widely known. There is not enough 'demand-pull' information from potential users. Neither is there enough information available that helps them to select the right tool themselves – as opposed to taking what others want or suggest/promote. Given the prevalence of 'top-down' material promoting particular mainstreaming techniques on the one hand, and the paucity of really effective mainstreaming to date on the other, the conclusion is that environmental mainstreaming capacity will be much stronger if stakeholders are able to select tools, methods and tactics that are relevant to their context. Some of these will be widely used and others still in development; some are easy to do and others demanding of skills and money; some are effective but others are not.

No.	Title	Source	Reference Typology	Location	Summary
60	Methodology for the GEF Transboundary Waters Assessment Programme. Volume 5. Methodology for the Assessment of Large Marine Ecosystems	UNEP, 2011	LME	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Policy Makers, Experts working on the TWAP project, Marine scientists, Marine spatial planners • PURPOSE: Guide for the assessment of the LMEs within the TWAP project with the aim of advising GEF for its future investments • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Indicators, data and information management, ecosystem assessment methodology • BASIC STRUCTURE: The methodology for assessment of Large Marine Ecosystems (LMEs) was developed under the Global Environment Facility (GEF) medium size project (MSP) 'Development of the Methodology and Arrangements for the GEF Transboundary Waters Assessment Programme (TWAP)'. LMEs, 64 of which have been defined globally, are natural regions of coastal ocean space encompassing waters from river basins and estuaries to the seaward boundaries of continental shelves and seaward margins of coastal currents and water masses. They are relatively large regions of 200 000 km² or more, the natural boundaries of which are based on four ecological criteria: bathymetry, hydrography, productivity, and trophically related populations. The documents provides methodological guidelines to execute the LMEs assessment. The approach to the assessment and management of LMEs is based on five modules, with corresponding suites of indicators: Productivity, Fish and Fisheries, Pollution and Ecosystem Health, Socio-economics, and Governance. A central theme of TWAP is the vulnerability of ecosystems and human communities to natural and anthropogenic stressors, and impairment of ecosystem services. A conceptual framework was developed that explicitly shows the links between human vulnerability and natural and anthropogenic stressors, ecosystem services and consequences for humans (with governance as an overarching concept), so that cause and effect can be better identified. This framework also accommodates other ecosystem services in addition to fish and fisheries. Further, it incorporates the five LME modules and integrates ecological, socio-economic, and governance indicators into a unified LME assessment framework. Special reference is given to natural drivers such as climate variability and the global threat of climate change.

No.	Title	Source	Reference Typology	Location	Summary
61	Methodology for the GEF Transboundary Waters Assessment Programme. Volume 6. Methodology for the Assessment of the Open Ocean	OC-UNESCO, 2011	OO	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Policy Makers, Experts working on the TWAP project, Marine scientists, Marine spatial planners • PURPOSE: Guide for the assessment of the Open Ocean within the TWAP project with the aim of advising GEF for its future investments • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Indicators, data and information management, ecosystem assessment methodology • BASIC STRUCTURE: A sister volume to Reference 60. For the purposes of TWAP, the open ocean is defined as the ocean areas beyond the defined LME areas. The proposed TWAP open ocean assessment will address these challenges through a globally-scoped assessment that directly addresses four broad themes: climate, ocean ecosystems, fisheries, and pollution. Rather than carving the open ocean into assessment units based on natural system criteria (which can vary depending on the scientific discipline consulted, and whether the surface, mid, or deep ocean is being considered), the assessment will take the cue from the human system side and the global governance arrangements already in place and focus on a global thematic assessment. Special section is related to climate change and variability. The assessment issues covered in this section are linked to human emissions of greenhouse gases, which create a natural system stress by changing the physical and chemical environment of the open oceans. The physical changes having direct consequence for human population are sea-level rise, increased ocean heat content, changes in global patterns of rainfall and drought, impacts on corals, primary productivity and distribution and transport of oxygen. Chemical change discussed is ocean acidification. The report describes a number of indicators related to climate change.
62	Climate change and the oceans – What does the future hold?	Marine Pollution Bulletin, 74, 2013	OO	External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers, experts developing projects • PURPOSE: Examination of major present and potential future impacts of climate change on the oceans • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Detailed analysis of physical and chemical impacts: temperature rise, ocean acidification, and deoxygenation • BASIC STRUCTURE: The basic hypothesis of the paper is that combined impact of warming, acidification and deoxygenation is already having a dramatic effect on the flora and fauna of the oceans with significant changes in distribution of populations, and decline of sensitive species. In many cases, the impacts of warming, acidification and deoxygenation are increased by the effects of other human impacts, such as pollution, eutrophication and overfishing. The interactive effects of these impacts mirror similar events in the Earth's past, which were often coupled with extinctions of major species' groups. The paper reviews the observed impacts and, using past episodes in the Earth's history, set out what the future may hold if carbon emissions and climate change are not significantly reduced with more or less immediate effect. The paper gives very good description of the three basic impacts and can be very useful during project development phase.

No.	Title	Source	Reference Typology	Location	Summary
63	Climate Change in Coastal Zones of the Mediterranean: Background Paper	Priority Actions Programme Regional Activity Centre, 2010	CA	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers, experts developing projects • PURPOSE: Background information on major impacts of climate change on coastal areas • GEOGRAPHICAL AREA: Mediterranean • TECHNICAL AREA: Projection of major parameters, adaptation measures and related case studies • BASIC STRUCTURE: After reviewing the current national circumstances of MAP Contracting Parties, terms of their physical environment, their major ecosystems and their socioeconomic status, the document establishes a broad indication of sensitivity to climate change. The paper then considers current status of vulnerability and adaptation initiatives across MAP Contracting Parties (CPs), which involves a review of the range of plans and strategies and projects and programmes operative in the region at various temporal and spatial scales. The purpose of the review exercise was to establish a broad measure of the potential adaptive capacity associated with specific CPs. Through the course of this exercise, a number of approaches to coastal adaptation were show-cased with a view to highlighting best practice for subsequent application in a Mediterranean context. The measures, options and actions associated with discrete "types" of adaptation were discussed to inform the identification of the most relevant approaches for the complex range of climate change issues to which the MAP CPs are susceptible. The review has identified a number of key issues and information gaps that inhibit a proactive and coordinated approach to climate change adaptation in the Mediterranean coastal zone. Overall, the information contained within this report provides the necessary background information to develop recommendations for PAP/RAC, to support adaptation to climate change impacts in coastal zones, but could also have wider implications due to generic nature of many recommendations in the report.
64	A framework to investigate the economic growth impact of sea level rise	IOP Science, 2012	SLR	Download Here External Link	<ul style="list-style-type: none"> • AIMED AT: Policy makers, economic experts • PURPOSE: To analyze economic impacts of sea level rise, which is less analyzed aspect of climate change • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: To investigate the possibility that sea level rise impacts negatively on economic growth and represents an obstacle to development and poverty reduction • BASIC STRUCTURE: The paper provides background information on problem of sea level rise. Its contribution is threefold. First, it proposes a framework to discuss the economic growth impact of sea level rise. Second, it reviews the channels through which sea level rise can affect economic growth, namely the loss of land, the loss of infrastructure and physical capital, the loss of social capital, the additional cost from extreme events and coastal floods, and the increased expenditure for coastal protection. Finally, it discusses how existing studies on the direct impact of sea level rise could be used to investigate the resulting consequences on economic growth, emphasizes research needs on this question, and discusses consequences on migration. The main conclusion of this paper is that sizable impacts of sea level rise on economic growth and welfare are possible, at least at the regional scale, even though it is difficult to quantify this effect with current knowledge.

No.	Title	Source	Reference Typology	Location	Summary
65	The role of ecosystems in coastal protection - Adapting to climate change and coastal hazards	Ocean and Coastal Management, In Press	CA SLR	External Link	<ul style="list-style-type: none"> • AIMED AT: Experts developing project documents • PURPOSE: Review of possibilities ecosystems offer for coastal protection against impacts of climate change • GEOGRAPHICAL AREA: Global, emphasis on tropical areas • TECHNICAL AREA: Description of coastal ecosystems: coastal wetlands, coral reefs, mangroves, beaches, dunes and barrier islands; very good list of references • BASIC STRUCTURE: The paper starts with the hypothesis that coastal ecosystems, particularly intertidal wetlands and reefs (coral and shellfish), can play a critical role in reducing the vulnerability of coastal communities to rising seas and coastal hazards, through their multiple roles in wave attenuation, sediment capture, vertical accretion, erosion reduction and the mitigation of storm surge and debris movement. The paper describes the factors that affect the strength or efficacy of these ecosystem services in different locations, as well as management interventions which may restore or enhance such values. The authors argue that improved understanding and application of such knowledge form a critical part of coastal adaptation planning, likely reducing the need for expensive engineering options in some locations, and providing a complementary tool in hybrid engineering design. Furthermore, they argue that irrespective of future climate change, coastal hazards already impact countless communities and the appropriate use of ecosystem-based adaptation strategies offers a valuable and effective tool for present-day management. Maintaining and enhancing coastal systems will also support the continued provision of other coastal services, including the provision of food and maintenance of coastal resource dependent livelihoods.
66	The next generation of scenarios for climate change research and assessment	Nature, Vol 463, 2010	AM		<ul style="list-style-type: none"> • AIMED AT: Experts developing project documents • PURPOSE: Better understanding of climate change scenario-making aspects • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Description of next generation of scenarios • BASIC STRUCTURE: Advances in the science and observation of climate change are providing a clearer understanding of the inherent variability of Earth's climate system and its likely response to human and natural influences. The implications of climate change for the environment and society will depend not only on the response of the Earth system to changes in radiative forcings, but also on how humankind responds through changes in technology, economies, lifestyle and policy. Extensive uncertainties exist in future forcings of and responses to climate change, necessitating the use of scenarios of the future to explore the potential consequences of different response options. To date, such scenarios have not adequately examined crucial possibilities, such as climate change mitigation and adaptation, and have relied on research processes that slowed the exchange of information among physical, biological and social scientists. Here we describe a new process for creating plausible scenarios to investigate some of the most challenging and important questions about climate change confronting the global community.

No.	Title	Source	Reference Typology	Location	Summary
67	Long-term natural variability and 20th century climate change	PNAS, Vol. 106, No. 38, 2009	AM		<ul style="list-style-type: none"> • AIMED AT: Experts developing project documents • PURPOSE: Insight into climate variability • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Analysis of climate variability • BASIC STRUCTURE: Global mean temperature at the Earth's surface responds both to externally imposed forcings, such as those arising from anthropogenic greenhouse gases, as well as to natural modes of variability internal to the climate system. Variability associated with these latter processes, generally referred to as natural long-term climate variability, arises primarily from changes in oceanic circulation. Here we present a technique that objectively identifies the component of inter-decadal global mean surface temperature attributable to natural long-term climate variability. Removal of that hidden variability from the actual observed global mean surface temperature record delineates the externally forced climate signal, which is monotonic, accelerating warming during the 20th century.
68	4th IPCC Assessment Report: Regional Climate Projections	IPCC, 2007	AM		<ul style="list-style-type: none"> • AIMED AT: Experts developing project documents • PURPOSE: Present reliable regional climate projections per major world region • GEOGRAPHICAL AREA: Regional • TECHNICAL AREA: Regional projections of climate change • BASIC STRUCTURE: The summary statements for each world region presents the following: (1) Temperature projections: These are comparable in magnitude to those of the TAR and confidence in the regional projections is now higher due to a larger number and variety of simulations, improved models, a better understanding of the role of model deficiencies and more detailed analyses of the results. Warming, often greater than the global mean, is very likely over all landmasses. (2) Precipitation projections: Overall patterns of change are comparable to those of TAR, with greater confidence in the projections for some regions. Model agreement is seen over more and larger regions. For some regions, there are grounds for stating that the projected precipitation changes are likely or very likely. For other regions, confidence in the projected change remains weak. (3) Extremes: There has been a large increase in the available analyses of changes in extremes. This allows for a more comprehensive assessment for most regions. The general findings are in line with the assessment made in TAR and now have a higher level of confidence derived from multiple sources of information. The most notable improvements in confidence relate to the regional statements concerning heat waves, heavy precipitation and droughts. Despite these advances, specific analyses of models are not available for some regions, which is reflected in the robust statements on extremes. In particular, projections concerning extreme events in the tropics remain uncertain. The difficulty in projecting the distribution of tropical cyclones adds to this uncertainty. Changes in extra-tropical cyclones are dependent on details of regional atmospheric circulation response, some of which remain uncertain.

No.	Title	Source	Reference Typology	Location	Summary
69	Green Economy in a Blue World	UNEP, 2012	AM		<ul style="list-style-type: none"> • AIMED AT: Experts developing project documents • PURPOSE: Report prepared for Rio+20 Summit to present the need for and advantages of green and blue economy • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Sectoral presentation of green and blue economy, marine ecosystem services • BASIC STRUCTURE: This report highlights ways to reduce the environmental impact and improve the environmental, economic and social sustainability of traditional and emerging ocean-oriented economies. It shows where fisheries, tourism and maritime transportation can take steps to reduce their impact on the marine environment. In doing so, these industries themselves can become more efficient and profitable and sustainable and can contribute directly to the sustainability and productivity of other businesses and livelihoods that depend on healthy oceans and coasts. Marine ecosystem services have substantial economic value. While exact figures are still debated, attempts to estimate the value of coastal ecosystem services have found such values to be on the order of trillions of US dollars annually. The report emphasizes the need for ecosystem valuation, a growing field in academia, that helps us create new opportunities for reconciling use and protection of the coastal and marine environment. Payment for Ecosystem Services represent one of these opportunities, whereby the protection of valuable services such as clean water is financially supported by the beneficiaries of those services, often at much lower cost than more technology-driven approaches to service provision. The report shows that investment in Green Economy in a Blue World pays off.
70	The economics of ecosystems and biodiversity	TEEB, 2008	AM		<ul style="list-style-type: none"> • AIMED AT: Experts developing project documents • PURPOSE: Report prepared for G8+5 meeting to present the case for payment for ecosystem services • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Valuation of ecosystem services • BASIC STRUCTURE: Report presents results of the interim phase of a very large project financed by EU. The focus of this report is on developing a framework for valuation of ecosystem services with special reference to biodiversity.
71	Marine and coastal ecosystem services: Valuation methods and their practical application	UNEP, 2011	AM		<ul style="list-style-type: none"> • AIMED AT: Experts developing project documents • PURPOSE: Overview of valuation techniques • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Valuation of ecosystem services • BASIC STRUCTURE: This report sets out some of the most commonly used methods for economic valuation of ecosystem services, and explore their pros and cons in practical contexts for assessing management interventions in marine and coastal environments. Examples are used to illustrate a range of applications in policy development, decision making and communication, and to highlight some of the main challenges for valuation, and solutions. The aim is to provide initial guidance on the ways in which valuation can be useful in practical decision-making and management contexts.

No.	Title	Source	Reference Typology	Location	Summary
72	Climate models at their limit?	Nature, Vol. 486, 2012	AM		<ul style="list-style-type: none"> • AIMED AT: Experts developing project documents • PURPOSE: To point to the state of climate modeling in view of the 5th IPCC Assessment • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Climate change models and uncertainties • BASIC STRUCTURE: For the fifth major assessment of climate science by the Intergovernmental Panel on Climate Change (IPCC), to be released in 2012, climate scientists face a serious public-image problem. The climate models they are now working with, which make use of significant improvements in our understanding of complex climate processes, are likely to produce wider rather than smaller ranges of uncertainty in their predictions. To the public and to policymakers, this will look as though the scientific understanding of climate change is becoming less, rather than more, clear. The authors conclude that greater knowledge and improved models will always be desirable, but they should not be considered as a panacea for political and public reticence to action on climate change. Despite the uncertainty, the weight of scientific evidence is enough to tell us what we need to know.
73	Communication of the role of natural variability in future North American climate	Nature Climate Change, Vol. 2, 2012	AM		<ul style="list-style-type: none"> • AIMED AT: Experts developing project documents • PURPOSE: Show limits to climate predictability • GEOGRAPHICAL AREA: Regional • TECHNICAL AREA: Climate change models and uncertainties • BASIC STRUCTURE: As climate models improve, decision-makers' expectations for accurate climate predictions are growing. Natural climate variability, however, poses inherent limits to climate predictability and the related goal of adaptation guidance in many places, as illustrated here for North America. Other locations with low natural variability show a more predictable future in which anthropogenic forcing can be more readily identified, even on small scales. We call for a more focused dialogue between scientists, policymakers and the public to improve communication and avoid raising expectations for accurate regional predictions everywhere.
74	Do We Need Better Predictions to Adapt to a Changing Climate?	Eos, Vol. 90, 2009	AM		<ul style="list-style-type: none"> • AIMED AT: Experts developing project documents • PURPOSE: Show limits to climate predictability • GEOGRAPHICAL AREA: Global • TECHNICAL AREA: Climate change models and uncertainties • BASIC STRUCTURE: The authors state that the accuracy of climate predictions is limited by fundamental, irreducible uncertainties. For climate prediction, uncertainties can arise from limitations in knowledge, from randomness and from human actions. Some of these uncertainties can be quantified, but many simply cannot, leaving some level of irreducible ignorance in our understanding of future climate.



GEF IW:LEARN

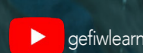
Intergovernmental Oceanographic Commission
United Nations Educational, Scientific and Cultural
Organization (IOC/UNESCO)

7 Place Fontenoy
75007 Paris, France

www.iwlearn.net
info@iwlearn.org

Produced by the GEF IW:LEARN project, managed by the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organisation, implemented by the United Nations Development Programme and the United Nations Environment Programme and funded by the Global Environment Facility.

Photo credits: Rocksweeper (covers), Karel Bartik, Mish Hamid, Krivinis, Christian Kohler, GEF UNDP Kura-Aras River Basin project, Goncharuk Maks, Max Gudczinski/IWC, AleksandrLu, Louis Lotter Photography, Douglas Olivares, Sutipond, Anna Om.



The Nature Conservancy



This global project is funded by the Global Environmental Facility (GEF), implemented by the United Nations Development Programme (UNDP), and executed by the Intergovernmental Oceanographic Commission (IOC) of UNESCO. The GEF LME:LEARN's Project Coordination Unit (PCU) is headquartered at UNESCO-IOC's offices in Paris.

<https://iwlearn.net/manuals/methodologies>



Empowered lives.
Resilient nations.

