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GEF IW:LEARN

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



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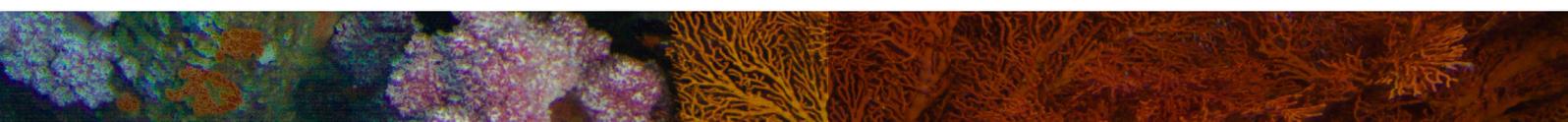
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Welcome

Lake Baikal: project credit

This GEF IW:LEARN guidance document is designed to assist GEF IW freshwater 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 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 freshwater (rivers, lakes, groundwaters and wetlands) projects—a companion guidance for marine (Large Marine Ecosystem, open ocean and coastal zones) 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

The Transboundary Diagnostic Analysis/Strategic Action Programme (TDA/SAP) approach is a highly collaborative 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 projects have approached climate change and variability, and presents options through selected reference materials from 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 freshwater types (rivers, lakes, groundwater and wetlands); and
- 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.

The UNDP-UNEP Poverty-Environment Initiative (PEI)

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 policy-making, 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."

Guidance prepared by the PEI highlights key messages to assist with mainstreaming climate change and variability into development and environment programmes:

- Climate change poses a risk to development and achievement of the MDGs. It affects livelihoods, health and economic development;
- Development affects a country's vulnerability to the adverse effects of climatic instability as well as its capacity to adjust and adapt;
- A country's adaptation response should be formulated as part of broader policies for development, including areas not directly related to climate change; and
- Mainstreaming climate change adaptation can be defined as the process of integrating adaptation considerations into policymaking, budgeting and implementation processes at the national, sector and sub-national levels.

Mainstreaming climate change adaptation is 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 upcoming SDGs (MDGs). It entails working with a range of government and non-governmental actors and other actors in the development field.

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](#).

1.3 Making Use of Published Climate Change Guidance

Part Three of this guidance provides a "guide to the guidance". Throughout this text, linkages are made to available guidance to help IW projects more easily identify potential relevant assistance and experiences. Linkages are also made to IW:LEARN manuals (specifically the TDA/SAP Manual and the Project Management Manual).

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:
 - Rivers
 - Lakes
 - Groundwaters
 - Wetlands

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 projects should consider at different stages of implementation;
- Suggests principles that can be utilized for IW projects that are consistent with the IWRM concepts;
- Presents potential climate issues relevant to different freshwater types (rivers, lakes groundwaters and wetlands);
- Provides guidance to ensure climate variability and change are integrated within IW project M&E and management; and
- Presents the multiplicity of tools, guidance and examples available within the international community to address climate variability and change in freshwater management.

2.1 Incorporating Climate Change Issues Within IW Projects

IW projects should be mindful of the following issues when considering climate change and variability in project implementation:

- 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 water resources;
- Demonstration activities within IW projects;
- Stakeholder involvement in climate change adaptation; and
- Incorporating climate change in sustainability and replication strategies

A number of GEF IW projects have already included climate considerations in their activities, including assessments of measures with regards to potential climate change (e.g. Kura-Aras and Tisza). Of particular relevance is the work undertaken by the UNEP Amazon River Basin project, which has initiated a number of demonstration activities (with SPA funds) to test different adaptation approaches to floods, droughts and sea level rise.



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

The following 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. Adaptation option or measures that would be justified under all plausible future scenarios, including the absence of man-made climate change;
- Dealing with uncertainty (see the [ICPDR Strategy on Adaptation to Climate Change](#));
- Integration of land and water management (see [Tisza](#));
- Measures. Management, capacity building, "making space for water", water conservation (domestic, industrial and agricultural);
- Informing stakeholders on both mitigation (e.g. carbon sequestration and benefits from C-trading, plus reducing GHG emissions) and adaptation approaches; and
- Assisting countries to develop robust policy to adapt to and thereby mitigate the impacts of climate change.

Guidance on Water and Adaptation to Climate Change – UNECE

Policy should create an enabling environment for adaptation to climate change through, among other things, policy and legal and institutional frameworks climate proofing and strong communication. Any policy should be based on the understanding that stable and unchanging baseline conditions no longer exist. Climate change adaptation should be integrated into existing policy developments. This integration can also enhance coherence among policy sectors and avoid potential conflicts. Spatial planning is an important basis on which to develop policies that take into account all sectors.

Policy development should be based on the principles of multi-level governance. Legislation should be developed in a flexible way and should not present barriers for adaptation. Transboundary agreements should include provisions for flow variability. The roles and responsibilities of institutions dealing with climate change adaptation should be clearly defined. A dedicated research team should be established to improve understanding of the implications of climate change for water resources and their management. Joint bodies should have the mandate, capacity and means to ensure they can execute their responsibilities in developing and coordinating adaptation strategies for transboundary basins. Proper education, capacity building and communication are imperative for climate change adaptation. (See the UNECE guidance [here](#)).

(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 elements of the project. 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 (see the [UNDP Poverty and Environment Initiative](#)).

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 PCU, in discussions with the PSC will review and amend these basic project documents to ensure that climate change is reflected in 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 [\[UNDP PEI\]](#):

- [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 [IMCs](#) including climate within policy plans? Are potential stress reduction actions (wastewater treatments, wetlands restoration/reconnections, implementation of agricultural buffer strips) including potential climate change scenarios in their planning and implementation? Have estimates of changes in water demand due to economic growth (industry, agriculture) included estimates of variations in water resources as a result of climate change? Approaches adopted by other projects of a similar water type; and
- [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.

It is important that within the TDA 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. (See documents [25](#) and [27](#) and “adaptation methodologies”).

See the [TDA/SAP Methodology](#) for detailed information on the TDA/SAP process and the [Project Management Manual](#) for guidance on managing it.

(4) Ecosystem Monitoring

Projects need sufficient monitoring data for evaluation of the potential impacts of climate change on the ecosystem.

In the [GWP Toolbox Climate change adaptation policies](#) a key lesson identified was the need for sound science and best practices as the foundation for adaptation decisions, sharing knowledge and information, and building comprehensive and sustainable data collection and monitoring systems. The availability of reliable monitoring data, or the development of a new system, is imperative to build up reliable baseline information for many activities. It is important for IW projects to consider the sustainability of such systems (such as collection of samples, analyses, data processing and interpretation) to ensure that countries and regions have the means to detect long-term changes and provide reliable information for management actions and stakeholder communications. In addition, UNECE has prepared highly relevant guidance on water and climate change monitoring (see box below).



Guidance on Water and Adaptation to Climate Change – UNECE

Adaptation to climate change requires a multi-stakeholder approach to identify data needs according to the principles of IWRM. Data collection should cover all aspects of the hydrological cycle, considering the needs of the final users, but not be limited to it. Data collection should also cover explicit information on water uses. Information sharing between sectors, especially at the transboundary level, is essential to jointly assess the vulnerability to climate change impacts. Historical monitoring stations should be maintained to have sufficient time series of data. Monitoring and observation systems should be ready to adapt to the changes in information needs that could occur in the future, and should consider the interactions between the different variables. Information for disaster risk reduction, e.g., considering environmental and social vulnerability assessment, is of crucial importance. (See the UNECE guidance [here](#)).

Monitoring is an expensive process. Ensuring that the objective of the monitoring is well specified will help to minimize costs for both the project and subsequently for national sustainability. A basic monitoring programme should consider collecting information on targeted quality parameters (e.g. dissolved oxygen, nutrients, BOD/COD), quantity (water level, discharge) and key biological indicators (where appropriate) to detect and/or assess the overall ecological condition of the water body (see documents [11](#), [12](#), [25](#) and [36](#) for more information).

(5) Climate Change scenarios and linkages to water resources

IW 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 approaches have been adopted in the UNDP/GEF Kura-Aras River project [see report [here](#)] and the Danube Basin [see report [here](#)] and their approaches and lessons are captured in Box X and Y and in the reports collated [here](#). The approach of the UNDP/GEF Kura-Aras project can be seen as an example of good practice by utilizing national expertise involved in the preparation of the Second National Communication to UNFCCC to develop the regional understanding of climate variability and change, and the potential impacts on water resources. See the Danube, Tisza and Kura-Aras approaches for real life scenarios.

(6) Demonstration Activities

Most GEF IW projects include some demonstration activities as a precursor to upscaling and/or replication. Projects should ensure that these activities are undertaken with potential climate change in mind where appropriate. This necessitates considering:

- 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 the “no regrets” concept;
- 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.

The [Project Management Manual](#) has guidance on demonstration projects and there is a rich collection of [references on adaptation](#).

(7) Stakeholders

"Stakeholders" are key partners of all IW projects and as such the PCU has an obligation to keep the many interested groups updated on aspects of the project. Climate change is critical in water governance in the context of reducing vulnerability of the poor, to maintain sustainable livelihoods and support sustainable development.

Stakeholder engagement occurs throughout the project cycle, from inception through policy development, implementation and monitoring. An initial stakeholder mapping and analysis is essential to projects undertaking a TDA/SAP, but are also beneficial to all GEF IW projects.

During the main implementation of the project, the PCU should consider preparing information targeted to specific groups of stakeholders (such as government institutes, communities and schools) 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.

The [Project Management Manual](#) contains general guidance, while documents [9](#), [11](#), [12](#), [22](#) and [35](#) provide specific information.

(8) Adaptation Strategies

Guidance on Water and Adaptation to Climate Change

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. (See the UNECE guidance document [here](#)).

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.



(g) Sustainability and Replication Strategies

All GEF IW projects are expected to develop sustainability plans and to encourage replication, both within the project region and globally through dissemination of experiences and lessons. Both replication and sustainability of project activities should take potential climate change and variability into consideration in the development of strategies.

The [Project Management Manual](#) contains guidance, which is supplemented by [associated documents](#) on Sustainability and Replication

2.2 Checklists on Climate Change Issues for IW 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	What expert assistance on climate change is needed?	Reviewing the project's M&E plan
What	<p>The project should clearly define the limits of the freshwater basin and responsible bodies.</p> <p>Advice on these will come from a range of sources, including the Project Document, but in all cases these limits should be confirmed with the PSC during the inception period. These include:</p> <ul style="list-style-type: none"> • Geographical boundaries (of the basin) • Time periods for consideration (e.g. 10, 25, 50, 100 years). • Involved sectors and ministries responsible 	<p>The UNFCCC website provides a wealth of information that should be consulted by GEF IW projects, including:</p> <ul style="list-style-type: none"> • Guidance on socio-economic data and tools • Gender and climate change information • A search of the site will provide documents on economic valuation of climate impacts (and adaptation approaches). <p>The project should identify sources of information (with the assistance of national counterpart organizations, ministries of environment, water, economy, PSC members, etc.) including:</p> <ul style="list-style-type: none"> • Climate models / reviews of approaches (as given above by UNFCCC) • Socio-economic trend data (e.g. population changes, water usage by sector, for example agriculture demand, industry, transport, etc.). See for example the Kura-Aras TDA • Monitoring information (e.g. river discharge, temperature, rainfall, etc.). For example what data is currently available for what time period? • Data owners and databases within the region (for example ministries, institutes, academia, identified by national experts and / or counterparts and approved for use in the project by the PSC) • UNFCCC national responses (see here for recent national communications) 	<p>The project should identify national/regional expertise to assess climate change reports and collect/collate information, for example:</p> <ul style="list-style-type: none"> • Identifying additional national experts (academic, civil society/ NGOs, etc.). An example of a ToR for national experts to assist can be found in the Project Management Manual • Identifying institutions involved in the UNFCCC Communications • Ministries involved in approving/ reporting UNFCCC Communications • Undertaking economic valuations of the impact of transboundary issues (including climate change. See the UNFCCC approaches referenced above) 	<p>The project should review and assess the need for mainstreaming climate change considerations within the M&E framework, including:</p> <ul style="list-style-type: none"> • Indicators – are these relevant for assessing climate resistant activities? For example, ensuring that climate risk analysis is included in the development phase of demonstration activities. Will the monitoring detect long-term changes? Advice can be expected from national experts or institutes and should be supported by the PSC to encourage sustainability post-project. • Identifying sources of information to provide baseline on climate issues and ongoing monitoring information (water resources, climate, socio-economic etc.). See the UNFCCC approaches to socio-economic data and tools listed above and the approach used in the Kura-Aras TDA • Use of international sources of data and tools (see references 44, 45, 46, 47, 48).
Who	PCU/National Experts PSC Inception Meeting	PSC PCU National focal points, ministries, institutions UNFCCC	Inter-ministerial committees National Governments Project Partners National Universities	PCU PSC

2.2.2 Implementation phase

Issues and Actions for Consideration in the Inception Phase					
Issue	Commissioning studies	Assessing climate change impacts and needs for mainstreaming climate considerations within demonstration activities	Developing monitoring plans	Reviewing adaptation approaches	Maintaining M&E parameters and updating results framework
What	<p>The project is likely to require expert advice through consultants and/or partners relating to, for example:</p> <ul style="list-style-type: none"> Assessing climate model outputs (see Part Three references for examples of models and assessment) Agreeing baseline conditions and socio-economic factors (such as water availability, demand, population, employment by sectors and health. All issues that have demand or impact on water/land) Developing trend scenarios with sector representatives Assessing impacts on sectors (e.g. water demand on agriculture, changes of crops, lack of water) Ecosystem valuation assessments (have these been used within TDAs or other activities?) Understanding (and explaining) uncertainty in the outputs Involving stakeholders 	<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 considerations could include:</p> <ul style="list-style-type: none"> Reviewing demonstration activities to ensure "no regrets" principles followed with regards to interventions Strengthening local understanding on mitigation of climate impacts and adaptation to change Developing 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"> Utilizing national and regional data sets on long-term monitoring (water quality, quantity, biology, sediments) for assessing impacts of floods, droughts and water quality issues. Assisting with developing and implementing programmes to collect/analyze water resources and climate data where needed Identifying 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>The project should consider reviewing current activities within the country/region on adaptation approaches and evaluating against climate change scenarios, and developing a database of experiences to capture lessons on climate change adaption (for incorporation within other IW project activities and contributing to the knowledge base within this guidance).</p>	<p>The project should continue to ensure the collection and analysis of data for project indicators and periodic review of project results framework to assess and report progress. (Indicators will be given in the Project Document, but additional indicators could be developed to assist PCU and long-term sustainability linked to monitoring plans, e.g. rainfall, temperature and river flow. See Kura-Aras TDA.)</p>
Who	PCU	PCU National Experts	PCU PSC National Experts	PCU National Experts	PCU PSC

2.2.3 Project closure

Issues and Actions for Consideration in the Inception Phase		
Issue	Assessment of project activity sustainability	Has a post project monitoring strategy been developed, adopted and funded by the country / regional body?
What	The project should make a final assessment of how activities implemented under the GEF project can be sustained and 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"	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 Freshwater Type

This issues identified in the next pages are not exhaustive but indicative of the type of issues freshwater IW projects should be considering. A simple summary of key issues is presented for rivers, lakes, groundwaters and wetlands. However, when following an IWRM approach projects should be aware of the significant inter-linkages among these water types.

Climate variability and change will have impacts on both the amount of precipitation and the annual distribution, which, linked with extreme events, can lead to additional problems from poor water retention on land (for example in winter) and excess erosion with impacts for both water quality (e.g. nutrients pollution) and sediment transport.

(1) RIVERS

Potential water quantity related impacts from climate change (flood, drought and scarcity)

- Risks to physical structures
- Sediment transport (links with water quality)
- Low flow / ecological flow requirements (links with water quality)
- Changing demands from sectors utilizing the water resources (especially agriculture)
- Flooding damage and potential of pollution as a result of flooding

Potential water quality related impacts from climate change (pollution, ecological flows, sediment)

- Run-off (agriculture, urban) transporting nutrients and organic matter
- Point sources from untreated storm drains
- Flooding of hazardous sites resulting in toxic pollution loads
- Sediment transport/deposition from increased (and decreased) discharge and impacts on turbidity

Potential ecosystem-related impacts from climate change within river basin systems

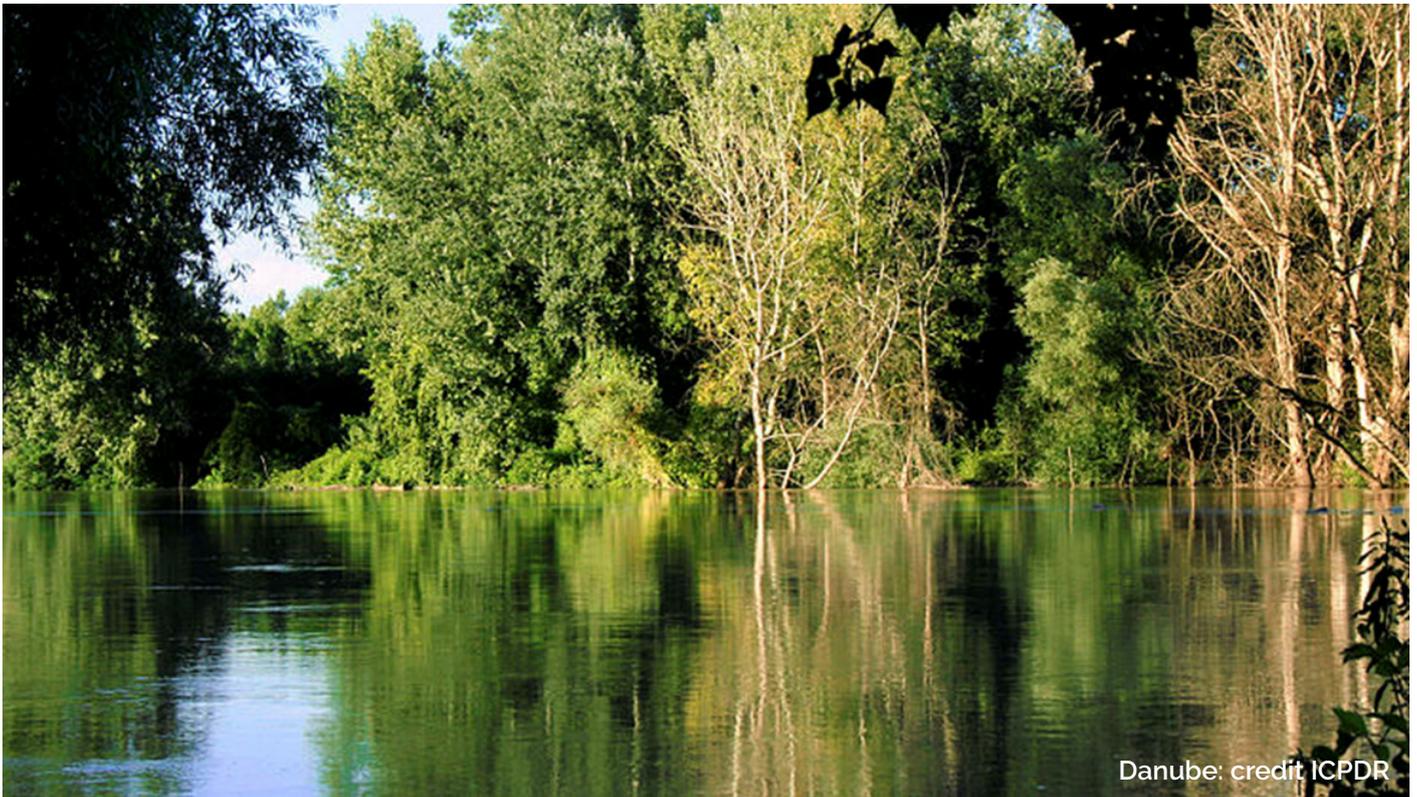
- Change in species distribution due to temperature, dissolved oxygen, transparency, sediment and pollutants
- Fisheries. Risks from pollution, increased temperature or insufficient flow to maintain oxygen
- Insufficient water (scarcity, droughts) for irrigation
- Loss of biodiversity/negative impacts on ecosystem as a whole

Danube River Basin - Strategy on Adaptation to Climate Change

The International Commission for the Protection of the Danube River Basin (ICPDR) has recently prepared a river basin management plan (in accordance with the requirements of the EU Water Framework Directive) and is currently in the process of updating this plan. As part of the plan the ICPDR has developed a strategy that is designed to assist the countries of the Danube Basin implement measures that adapt to a changing climate that is expected to have a significant impact on the water resources of the basin. The strategy responds to the crosscutting issues of the multiple sectors that utilize the water resources. The strategy was developed on the basis of expert collaboration in reviewing the climate change scenarios for the basin (including temperature, precipitation extreme events) and evaluating the potential impacts across the basin. The strategy also presents an approach for dealing with uncertainty in the estimates.

The ICPDR identified key lessons from developing a strategy for adaptation to climate change within river basins and offered the following suggestions to this guidance:

- Creation of a common knowledge base for the whole international river basin on climate change and expected changes. This is a required basis for joint decision making;
- Interdisciplinary approach since climate change is a crosscutting issue;
- Focusing on the basin-wide level—on the issues required to be coordinated on the basin-wide level; country-specific issues can be addressed more concretely on the national level;
- Cyclic approach, requiring an update of the strategy and (adaptation) plans on a regular basis, allowing more concrete knowledge to be taken into account in the future and allowing room to deal with uncertainty;
- Recognizing that the time frame (decades) are relevant for the socio-economic developments in a basin, e.g. agricultural development, energy infrastructure, population growth etc. and these may impact a river system even more than climate change and will compound the overall impacts on water resources.



Tisza River Basin - Integration of Land and Water Management

Over the last 150 years, most of the natural wetlands and floodplains within the [Tisza River Basin](#) have been lost through land reclamation for agriculture or developments or flood defence schemes. These natural riverine features offer multiple benefits such as retaining harmful levels of nutrient pollution, buffering floodwaters and improving biodiversity.

By developing an integrated management plan, linking issues of land and water management together with concerns of water quantity and quality, the countries are better equipped to address regional issues affecting the river and developing approaches to mitigate the impacts of varying climate and extreme events. For too long the often competing requirements of land management (agriculture, forestry, urban development) have not been involved in helping to develop and implement strategies for water management—which in return can lead, for example, to reduced flood damage to economically and socially important areas. In developing the Integrated River Basin Management Plan national assessments on potential climate change (based on extensive research) were included in identifying measures for addressing the transboundary problems and in further strengthening the management of land and water. This recognized the importance of wetlands and floodplains in the future measures to mitigate floods and the multiple benefits that wetlands also offer the environment.

Kura Aras River Basin - TDA

In developing a Transboundary Analysis (TDA) as a component of the overall Strategic Action Programme (SAP), the UNDP/GEF Kura-Aras project (Armenia, Azerbaijan and Georgia) reviewed regional development and climate change and variability trends. This review assessed both the future demand for water resources based on socio-economic trends (economic development from industry, agriculture, power and population growth) and potential climate change impacts on water resources.

To prepare this informative section within the **TDA**, the project undertook a detailed study focusing on climate issues utilizing both material and national expertise from the Second National Communication to the UNFCCC. (Such information should be investigated at the national level through ministries/institutes responsible for UNFCCC reporting. Projects should identify these information sources during the inception phase).

This detailed study focused on key issues for climate variability and change relevant to the region, with data from both observation and models addressing:

- Observed temperature and precipitation over past decades;
- Frequency and intensity of extreme events (drought, flooding, frost, wind, etc.);
- Projected climate changes based on outputs from several global circulation models to indicate potential temperature and precipitation changes with linkages to impacts on water resources (both surface and groundwater);
- An assessment, based on various scenarios, on overall water resources and the impacts on economic activities within the region.

(2) LAKES

In addition to the issues and impacts indicated for rivers, the following should be considered for lakes:

- Temperature / stratification / turnover (including impacts of change in wind regime)
- Level (increase and decrease) and impacts on margin ecosystems



Lake Baikal, GEF Flickr

Case Study on approaches adopted by UNDP/GEF Lake Baikal project to climate change

In preparing a TDA as part of the Lake Baikal SAP, the national climate reports prepared by the countries (in Mongolia, 2009 UNEP and UNDP prepared reports were utilized. These were supplemented by additional UNDP and UNFCCC guidance (see 9 and the bibliography in 34).

The demonstration activities are concentrating on reducing anthropogenic threats, habitat fragmentation and degradation. All project pilot activities will include climate change estimation and recommendations for changing policy, reducing external stressors on the ecosystems and increasing its resilience to potential climate change.

(3) GROUNDWATERS

Potential considerations for climate change impacts on groundwaters include:

- Recharge rate changes due to varying precipitation
- Changes in demand for water (e.g. industry, irrigation)
- Impacts of reducing (and increasing) water level on energy costs for pumping
- Impacts on ecosystems (e.g. wetlands) dependent on groundwaters
- Direct quantity and quality impacts (recharge, interactions with seawater etc.) and indirect (changes in human use as a result of climate change). (See Impacts of Climate Change and Human Activities on Groundwater Resources presentation here).

UNESCO Groundwater Resources Assessment under the Pressures of Humanity and Climate Change

This is a compilation of 20 case studies from more 30 different countries that have been carried out under the framework of the UNESCO-IHP GRAPHIC project. The case studies presented in this volume represent aquifers from all the major climate regions of the world. The studies address groundwater resources in a range of hydrogeological settings from mountainous to coastal aquifer systems, including unconfined, semi-confined, and confined aquifers in unconsolidated to fractured- rock material. More details on each case study location, climate, hydrogeological setting, land use, groundwater use, as well as subjects addressed and methods applied are presented.

This volume is organized by case study according to the major climate groups of the Köppen- Geiger climate classification scheme: tropical, dry (arid and semi-arid), temperate, continental, and polar climates. The introduction of each chapter describes the purpose and scope, study area, methodology, and relevance to the project. The results and discussion are followed by recommendations for water managers and planners, as well as policy and decision makers. Finally, the continuation of research activities and future work are outlined.

For more information, see 42, 24, 26, 16 and 39.



(4) WETLANDS

Wetlands overlap with rivers, lakes and groundwaters. In addition, peat bogs provide unique habitats (and offer valuable water storage capacities) that will be significantly affected by potential climate change.

Wetlands and floodplains also offer important means to mitigate the problems of floods (or potential in cases where flood defences have disconnected historic wetlands). They offer significant ecosystem benefits and functions, including nutrient retention, flood retention and water storage, and have important biodiversity functions.

For more information see [38](#) (including case studies), [39](#) and [41](#).



3. References

References for Addressing Climate Change and Variability in GEF IW Freshwater 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
 - Rivers (RI)
 - Lakes (LA)
 - Groundwater (GW)
 - Wetlands (WT)

No.	Title	Source	Reference Typology	Location	Summary
1	Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment	EU	GT PG	Download Here External Link	<p>Climate Change Adaptation in Europe</p> <p>The European Climate Adaptation Platform (CLIMATE-ADAPT) aims to support Europe in adapting to climate change. It is an initiative of the European Commission and helps users to access and share information on:</p> <ul style="list-style-type: none"> • Expected climate change in Europe • Current and future vulnerability of regions and sectors • National and transnational adaptation strategies • Adaptation case studies and potential adaptation options <p>Tools that support adaptation planning</p>
2	European Climate Adaptation Platform	EU	PG GT AM	External Link	<p>The European Climate Adaptation Platform (CLIMATE-ADAPT) aims to support Europe in adapting to climate change. It is an initiative of the European Commission and helps users to access and share information on:</p> <ul style="list-style-type: none"> • Expected climate change in Europe • Current and future vulnerability of regions and sectors • National and transnational adaptation strategies • Adaptation case studies and potential adaptation options <p>Tools that support adaptation planning</p>
3	Coalition to address water issues in climate change	Water and Climate Coalition, WCC	WP	External Link	<p>The Coalition for Water and Climate (Water and Climate Coalition, WCC) is a global coalition that seeks to place water management in the heart of policy responses to climate change. It seeks to combine the various actors in the water community and promote an integrated gradually and international policies on water and climate change intergovernmental processes where water and climate are relevant.</p> <p>The WCC is proposing the establishment of a water and climate change under the UN Framework Convention on Climate Change (UNFCCC for its acronym in English). In the roadmap developed for the Bonn meeting in August 2010 as part of the preparatory meetings for COP-16, and reviewed for the meeting of Tianjin in October 2010, the coalition has shown that water is crucial for adaptation and mitigation and has built the case for greater emphasis on water under the UNFCCC through a specific work program.</p>
4	Adaptation Tools for Public Officials	US EPA	WP	External Link	<p>A number of resources exist to help public officials and others with climate change adaptation planning. The tools, guidebooks, clearinghouses and other resources highlighted on this page offer a sampling of what is available from states, federal agencies, nonprofit and private organizations, and others.</p>
5	Private Sector Initiative -database of actions on adaptation	UNFCCC	WP AM	External Link	<p>Private Sector Initiative - database of actions on adaptation</p> <p>While climate change poses a number of risks to vulnerable communities and businesses around the world, many opportunities are unfolding for private companies to implement actions towards reducing risks to their business operations, as well as investing in adaptation action in vulnerable regions in a sustainable and profitable manner, including:</p> <ul style="list-style-type: none"> • New market opportunities and expansions; • Development of climate friendly goods and services; • Potential cost savings; • Risk reduction measures, including physical operations; • Climate proofing the supply chain; • Enhanced corporate social responsibility

No.	Title	Source	Reference Typology	Location	Summary
6	Down to Earth: Territorial Approach to Climate Change (TACC)	UNDP/ UNEP	WP TR	Download Here External Link	<p>Territorial Approach to Climate Change (TACC)</p> <p>TACC is the outcome of a partnership between UNDP, UNEP and eight key networks of sub-national governments involving over 1,000 Regions. Recognizing that 50-80% of GHG emissions reductions and the bulk of adaptation efforts will depend on decisions taken at the sub-national level, the TACC partnership aims to empower sub-national governments to lead the global fight against climate change.</p>
7	Project: Every Drop Matters: Inclusive Community-based Water Management and Adaptation to Climate Change project for Catalyzing Achievement of the MDGs	UNDP	AM SI	Download Here External Link	<p>A new partnership between Coca Cola Company and UNDP which will work in over 30 countries in Middle East/N. Africa, Central Europe, C. Asia and South Asia. Co-finance to IW:LEARN will be delivered via cooperative; advocacy, outreach and awareness raising to promote responsible water resource management and sanitation/hygiene practices</p>
8	Climate Change Adaptation and Development	UNDP	WP PG GT AM	Download Here External Link	<p>UNDP methodologies and resources to support countries in adaptation initiatives:</p> <p>Adaptation Policy Framework (APF): A comprehensive guidebook for countries to help design and implement adaptation strategies, policies, and measures, which ensure the goals of human development, are met in the face of climate change. https://www.adaptation-undp.org/sites/default/files/downloads/adaptation_policy_frameworks_for_climate_change_-_developing_strategies_policies_and_measures_0.pdf</p> <p>Toolkit for Designing Climate Change Adaptation Initiatives: An additional resource to provide guidance on key steps, checklists and training materials to support climate change adaptation projects. https://www.undp.org/content/undp/en/home/librarypage/environment-energy/low_emission_climate_resilient_development/designing-adaptation-initiatives-toolkit.html</p> <p>Strategic Environmental Assessment (SEA): An approach to adaptation used to integrate considerations related to climate change into national development, sectoral management planning or policymaking processes.</p> <p>Country Adaptation Profiles: A series of national studies of climate observations with multi-model projections reflecting trends – old and new. https://www.geog.ox.ac.uk/research/climate/projects/undp-cp/</p>

No.	Title	Source	Reference Typology	Location	Summary
9	Adaptation to Climate Change	UNDP	WP TR	External Link	<p>Climate Change Adaptation and Water</p> <p>Water resources have always varied in time and space. Drainage patterns, flora and fauna have developed accordingly, water resources management likewise. The core business of water resources management is about coping with variability: storing excess water from wet periods to bridge dry spells, protecting low lying areas from floods, balancing withdrawal between upstream and downstream areas and between different uses etc. From the lens of water management climate change therefore does not entail something radically new; it means that the dynamic characteristics of the water cycle have changed. And perhaps even more important, it means that these characteristics no longer are stationary over the life span of current and planned water infrastructure. A changing climate is directly felt in the water sector; consequently, much work on adaptation and building resilience needs to be done through the water sector.</p> <p>Adaptation to the impacts of climate change will be expensive and will require difficult policy shifts. UNDP works with countries to strengthen the governance and improving the management of water accompanied by investment in infrastructure projects, such as wastewater treatment facilities and structures for water storage and flood control.</p> <p>It is critical climate change in water governance in the context of reducing vulnerability of the poor, to maintain sustainable livelihoods and support sustainable development. UNDP promotes multi-stakeholder dialogue (involving more than just water managers), address issues relating to development, planning and fiscal incentives. UNDP also supports mechanisms to strengthen the capacity of governments and civil society organizations to assess the impact of climate variability and change on integrated water resources management, and assists the formulation of adaptation strategies to integrate these impacts into poverty reduction strategies, and national and local development planning."</p> <p>In summary UNDP's role for climate change adaptation in the water sector is to:</p> <ul style="list-style-type: none"> • Raise awareness of water and climate issues and integrate climate change consideration into water governance reform, participatory scenario planning and capacity building for water resources management, water supply and sanitation • Enhance national institutional capacities to build resilience and mainstream climate change adaptation into water resource management and decision making processes • Assess financing requirements, sources and flows for adaptation response measures • Support vertically integrated development, coordination and implementation of water related climate change adaptation strategies – transboundary, national, local scales. • Facilitate a coordinated UN system support at national level • Develop knowledge products from on the ground lessons learned to help guide decision making and promote replication in other countries. <p>A constraining factor is the lack of accurate regionally and basin specific climate change data and the considerable uncertainty in the potential range of variation in the predictions, but in many instances we know what we need to do: improve the governance and management of water resources. Strengthening resilience and capacity to manage today's climate is often an appropriate response to future climate change threats. Therefore the focus on adaptation could also become a development opportunity with positive impacts on all the MDGs</p>

No.	Title	Source	Reference Typology	Location	Summary
10	IWRM a Tool for Adaptation to Climate Change	UNDP / CapNet	WB GT AM TR SI	Download Here External Link	<p>These training materials are intended to increase our understanding about climate change and to explore what we can do now. There are actions that can be taken to prepare for a more variable climate and we can make a case to our policy makers to prepare for change. The most important immediate action concerns the way we manage our water resources. Improving our management of water today will prepare us to adapt tomorrow. Improved understanding of our water resources will allow more efficient and flexible allocation systems and better investment in infrastructure, both to improve access to water and reduce risks from climate change. We can act now and these training materials can help us to identify those actions.</p> <p>Other materials are available from Cap-Net that cover more specific issues of climate change, such as hydro-climatic disasters, urban flood management and community management of floods.</p>
11	Guidance on Water and Adaptation to Climate Change	UNECE	PG	Download Here External Link	<p>The UNECE Guidance aims to support decision makers from the local to the transboundary and international level by offering advice on the challenges caused by climate change to water management and water-related activities and thereby to develop adaptation strategies.</p>
12	Mainstreaming Climate Change Adaptation into Development Planning: A Guide for Practitioners	UNDP/ UNEP	PG GT AM SI	Download Here External Link	<p>Efforts to mainstream climate change adaptation into national development planning are still at a relatively early stage in many countries. Countries are increasingly requesting the United Nations Development Programme–United Nations Environment Programme Poverty–Environment Initiative (PEI) to tackle the mainstreaming of climate change adaptation into their national development planning, as part of broader poverty–environment mainstreaming efforts. The present guide addresses this need for integrating climate change adaptation considerations into the work of PEI. In addition, by building on PEI lessons in the field of poverty–environment mainstreaming in general, the guide can provide useful insights to adaptation specialists interested in mainstreaming their efforts. The framework proposed in this guide 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.</p> <ul style="list-style-type: none"> • Finding the entry points and making the case is concerned with setting the stage for mainstreaming. This entails understanding the linkages between climate change and national development priorities, as well as understanding the governmental, institutional and political contexts and needs, in order to define pro-poor adaptation outcomes on which to focus. • Mainstreaming adaptation into policy processes focuses on integrating adaptation issues into an ongoing policy process, such as a national development plan or sector strategy. Such efforts are based on country-specific evidence, including impact, vulnerability and adaptation assessments, socio-economic analysis, and demonstration projects. • Meeting the implementation challenge aims to ensure 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. <p>Because efforts to mainstream climate change adaptation into national development planning are still at a relatively early stage in many countries, the proposed approach will need to be tested and improved as the wealth of experience across regions increases. By continuing this work, practitioners can help ensure that climate change adaptation is factored in a way that reduces poverty, promotes sustainable economic growth and helps achieve the Millennium Development Goals.</p>

No.	Title	Source	Reference Typology	Location	Summary
13	Screening Tools and Guidelines to Support the Mainstreaming of Climate Change Adaptation into Development Assistance	UNDP	WP GT	External Link	The report provides an overview of existing tools and good practices introduced by various organizations to guide development practitioners in their climate change mainstreaming efforts. It also 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 process. Based on relevant literature and practices, the report discusses and illustrates key climate change adaptation and mainstreaming concepts and their relation to development; explores climate risk screening efforts; and provides a comparative analysis of climate risk screening tools. It concludes by underlining the need for a common language on climate change mainstreaming, including clear definitions of key climate change adaptation and mainstreaming concepts, and transparent indicators for assessing climate change adaptation activities. Furthermore, "in order to make full use of the wealth of information provided through the development and piloting of climate risk screening tools and methods – and to secure consistency – there is a need to harmonize approaches to assessment and integration of climate risks in development activities."
14	Mainstreaming processes for climate change adaptation: collection of best practices	Secretariat of the Pacific Community and Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)	WP PG GT AM SI	Download Here External Link	This collection of best practices looks at successful mainstreaming efforts to provide policy makers and planners in the Pacific with ideas and lessons learned. The examples, which come from different regions and sectors including the Pacific, are not only illustrating adaptation to climate change. Many examples originate from other related mainstreaming efforts like disaster risk management or environmental mainstreaming. Interestingly, one major obstacle of mainstreaming has hardly been discussed in the literature reviewed, that is, so called 'mainstreaming fatigue'. This phenomenon describes the excessive demands placed on policy makers and development planners to take more and more issues into account, which, at first glance, are unrelated to the project goal. Common issues to be mainstreamed include gender, HIV/AIDS, conflict, environment and disaster risk reduction. The pressure to integrate progressively more of these important topics has continued, but it is obvious that people will undertake mainstreaming only if they are convinced that there will be an advantage in the long run. This can be an economic calculation or a demonstration that neglecting climate change might jeopardize the success of the project. The additional workload connected with the mainstreaming of adaptation to climate change can be reduced if effective and easy-to-use tools are available, which minimize the additional efforts.
15	The UN World Water Assessment Programme - Dialogue Paper Water Adaptation in National Adaptation Programmes for Action: Freshwater in Climate Adaptation Planning and Climate Adaptation in Freshwater Planning	UNDP (UNESCO)		Download Here External Link	

No.	Title	Source	Reference Typology	Location	Summary
16	The UN World Water Assessment Programme - Dialogue Paper Water and Climate Change: Citizen Mobilization, a Source of Solutions	SIWI (UNESCO)	SI AM	Download Here External Link	The objective of this paper is to discuss the responses of communities in the current context of consideration of extreme events and climate change, and to do so while demonstrating the importance of the commitment of leaders in this process. We begin by defining climate change, adaptation and the vulnerabilities associated with this phenomenon; we then describe sustainable adaptation strategies linked to specific real-world cases, and, finally, we discuss and propose possible solutions through the experience of the ISW and its partners in development, an approach that we believe is essential in a context of climate change.
17	The UN World Water Assessment Programme - Dialogue Paper Confronting the Challenges of Climate Variability and Change through an Integrated Strategy for the Sustainable Management of the La Plata River Basin	OAS (UNESCO)	RI	Download Here External Link	<p>The La Plata River Basin is one of the largest river basins in the world and drains approximately one-fifth of the South American continent, including the southern part of Brazil, the southeastern part of Bolivia, a large part of Uruguay, the whole of Paraguay, and an extensive portion of the central and northern parts of Argentina. Water and nutrients from the central regions of South America discharge through the La Plata River to the South Atlantic Ocean, creating in its maritime front one of the richest and most diverse marine ecosystems in the world.</p> <p>The La Plata River Basin is comprised of three large river systems: the Paraná River, the Paraguay River, and the Uruguay River. The Paraguay River has an average annual flow of 3,800 m³/s (at Pilcomayo Harbour); the Parana River has an average annual flow of 17,100 m³/s (at Corrientes); and the Uruguay River has an average annual flow of 4,500 m³/s. These last two rivers converge to form the La Plata River, which drains into the Atlantic Ocean, with an average output of 25,000 m³/s. A large wetland corridor links the Pantanal (in the headwaters of the Paraguay River) with the Delta del Parana, at its outlet to the La Plata River. This system of interconnected wetlands is essential to the existence of extensive area of biological diversity and productivity. Important groundwater systems include the Guaraní Aquifer System, one of the largest aquifers in the world comprised of confined deep groundwater bodies and the Yrenda-Toba-Tarijeño Aquifer System (SAYTT), entirely contained within the La Plata Basin in the semi-arid Chaco of Argentina, Bolivia and Paraguay. Climate change scenarios show an increasing process of desertification within this region, which, when combined with high poverty index values and the presence of indigenous communities, make the SAYTT a top priority for integrated surface-groundwater management.</p>

No.	Title	Source	Reference Typology	Location	Summary
18	The UN World Water Assessment Programme - Scientific Paper A Multi Model Experiment to Assess and Cope with Climate Change Impacts on the Châteauguay Watershed in Southern Québec	UNESCO	PG GT RI	Download Here External Link	<p>This paper discusses how participatory hydro-climatological modeling can be used to assess specific water issues on the Châteauguay watershed in southern Québec. It looks at different model responses regarding water budget dynamics, with a focus on summer water shortages and irrigation needs. It aims to stimulate water authorities' and managers' thoughts about climate-change adaptive planning options. The methodologies developed involve the use of a regional climate model providing climate information subsequently incorporated as forcing input (a) to two hydrological models (Hydrotel and Promet) and (b) to the FAO irrigation model. Results show that in climate-change scenarios for a 2050 time horizon, summer flows are projected to decrease while irrigation needs appear to increase considerably. The lesson learned from this modeling exercise reinforces the principle of forward-thinking, adaptive watershed-management strategies (regarding, in this case, water volume management for irrigation purposes). This exercise also shows that before proposing any adaptive solution, the issue needs to be assessed scientifically (in terms of water budget as well as in the socioeconomic domain) to evaluate the uncertainties of climate-change impact analysis, with respect to the multi-usage and integrated watershed management contexts of southern Québec.</p> <p>Climate change is in progress and affects many economic, social and ecological developments. In Southern Québec surface air temperature has increased during the period 1960–2005 and this warming is significantly evident in the western, southern and central parts of the province. In the summer, significant increasing temperature trends are found and precipitation indices indicate decreasing trends. Climate-change scenarios produced at Ouranos show that in the future, summer temperature will increase while no significant change is obtained for precipitation amount. This could lead to pronounced alterations in the seasonal water budget, putting increasing pressure on summer water availability and usage. Thus, reliable assessment of the potential climate-change impacts is necessary on a regional level. Suitable adaptation strategies must be developed in order to minimize adverse effects and to optimize possible benefits on water management issues. These adaptation schemes may profit largely from the careful integration of scientific model results into the decision processes of policy-making entities on different levels. This is not an easy task due to the manifold perspectives and interests in these issues. This paper discusses management issues arising from increasing agricultural water requirements under stressed water conditions, with the aim of optimizing possible benefits.</p>
19	Climate change and the future of freshwater biodiversity in Europe: a primer for policy-makers	Freshwater Reviews, Vol 2, No 2 (2009)		Download Here External Link	

No.	Title	Source	Reference Typology	Location	Summary
20	Climate Change 2007: Working Group II: Impacts, Adaptation and Vulnerability Chapter 3: Fresh Water Resources and their Management	IPCC	PG	Download Here External Link	<p>The report makes the following observations:</p> <ul style="list-style-type: none"> • The impacts of climate change on freshwater systems and their management are mainly due to the observed and projected increases in temperature, sea level and precipitation variability (very high confidence). • Semi-arid and arid areas are particularly exposed to the impacts of climate change on freshwater (high confidence). • Higher water temperatures, increased precipitation intensity, and longer periods of low flows exacerbate many forms of water pollution, with impacts on ecosystems, human health, water system reliability and operating costs (high confidence). • Climate change affects the function and operation of existing water infrastructure as well as water management practices (very high confidence). • Adaptation procedures and risk management practices for the water sector are being developed in some countries and regions (e.g., Caribbean, Canada, Australia, Netherlands, UK, USA, Germany) that have recognized projected hydrological changes with related uncertainties (very high confidence). <p>The negative impacts of climate change on freshwater systems outweigh its benefits (high confidence).</p>
21	The Nairobi work programme on impacts, vulnerability and adaptation to climate change	UNFCCC	PG AM	Download Here External Link	<p>The Nairobi work programme (NWP) on impacts, vulnerability and adaptation to climate change was adopted by the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) at its eleventh session, in 2005. The objective of the NWP is to assist all Parties, in particular developing countries, including the least developed countries (LDCs) and small island developing States (SIDS) to:</p> <ul style="list-style-type: none"> • Improve their understanding and assessment of impacts, vulnerability and adaptation to climate change; and • Make informed decisions on practical adaptation actions and measures to respond to climate change on a sound scientific, technical and socio-economic basis, taking into account current and future climate change and variability. <p>The report contains a synthesis of adaptation actions undertaken by Nairobi work programme partner organizations</p>

No.	Title	Source	Reference Typology	Location	Summary
22	Compendium on methods and tools to evaluate impacts of, and vulnerability and adaptation to, climate change	UNFCCC	PG GT SI	Download Here External Link	<p>This updated compendium is organized in a way that allows existing adaptation analysis and decision frameworks and tools to be catalogued in manner that is clear and easy to use and does not prescribe or recommend methods or tools. Whereas the original compendium for the most part organized discrete adaptation decision tools according to sectors of application, echoing the sectoral model based approach to vulnerability and adaptation assessment of the time, the organization of this revised compendium reflects the expanded scope and comprehensiveness of methods currently in use.</p> <p>Thus, the revised compendium attempts to reflect the current state of knowledge by collecting and summarizing three broad categories of frameworks, methods, and tools. First, it reviews some of the complete frameworks (both what are previously referred to as first generation approaches and second generation approaches), those methods that prescribe an entire process for the assessment of vulnerability and adaptation and in some instances assemble toolkits to support this process. These frameworks offer a broad strategic approach. Second, the compendium establishes a structure for cataloging tools that assist in addressing key crosscutting themes or whose application spans multiple steps of the assessment process, as well as discrete tools that are applicable to multiple sectors. These are not comprehensive frameworks, nor are they tools applicable only to a specific sector and step of an assessment framework. Some constitute partial frameworks or particular research orientations that prescribe an approach to undertaking an assessment (e.g., stakeholder analysis) and can be applied at various stages of the assessment. Others are tools that are applicable to more than one sector or tend to address a particular stage of an assessment (e.g., GCM downscaling, socioeconomic scenario building, decision making). Third this revised version organizes discrete tools specific to particular sectors. Much of the content of the original compendium has been conserved here. We have significantly updated the agriculture sector to reflect the development and use of new methods and tools.</p> <p>The compendium is intended for use by either assessment managers or technical researchers; it does not require extensive technical knowledge of modeling or specific decision-making techniques. Some of the frameworks and tools described in the compendium may require particular expertise, and these requirements are explicitly described.</p> <p>The compendium provides users with key information about available frameworks and tools, special features of each framework or tool, and information about how to obtain documentation, training, or publications supporting each tool. It has been designed to be used as a reference document to identify available frameworks and tools for assessing vulnerability and adaptation. This is not a manual describing how to implement each tool, but rather a survey of possible tools that can be applied to a broad spectrum of situations and a map to point users to additional sources of information.</p> <p>Each framework or tool is described in a summary table that summarizes its key features. With these tables as a reference, users can decide which frameworks and tools they want to use and then can obtain further documentation for the listed contact to fully evaluate each option. Each tool has been summarized to identify its potential applications. Looking at the resources available and the individual needs of the project, the user can identify which tools may be most appropriate to analyze the adaptation options they are considering.</p> <p>The compendium is not a "cookbook." It does not provide full documentation for frameworks, models, or other tools. Users will need to obtain this information from the providers. Furthermore, users should carefully consider the alternative frameworks and tools discussed in the compendium. The appropriateness and usefulness of each may vary depending on users' circumstances and information needs. Options for analysis should be carefully investigated and considered.</p>
23	Adaptation Practices	UNFCCC	WP	External Link	<p>Adaptation Practices</p> <p>The adaptation practices interface is a gateway to information on adaptation practices worldwide. It provides a summary of adaptation practices by a large range of organizations, agencies and businesses, along with descriptions and relevant links and publications.</p>

No.	Title	Source	Reference Typology	Location	Summary
24	Climate Change Effects on Groundwater Resources A Global Synthesis of Findings and Recommendations	UNESCO (Eds)	PG GW	Download Here External Link	<p>This is a compilation of 20 case studies from more 30 different countries that have been carried out under the framework of the UNESCO- IHP GRAPHIC project. The case studies presented in this volume represent aquifers from all the major climate regions of the world. The studies address groundwater resources in a range of hydrogeological settings from mountainous to coastal aquifer systems, including unconfined, semi-confined, and confined aquifers in unconsolidated to fractured-rock material. More details on each case study location, climate, hydrogeological setting, land use, groundwater use, as well as subjects addressed and methods applied are presented.</p> <p>This volume is organized by case study according to the major climate groups of the Köppen- Geiger climate classification scheme: tropical, dry (arid and semi-arid), temperate, continental, and polar climates. The introduction of each chapter describes the purpose and scope, study area, methodology, and relevance to the GRAPHIC project. The results and discussion are followed by recommendations for water managers and planners, as well as policy and decision makers. Finally, the continuation of research activities and future work are outlined.</p>

No.	Title	Source	Reference Typology	Location	Summary
25	GWP Toolbox Climate change adaptation policies	GWP	WP PG GT	External Link	<p>Climate change adaptation policies</p> <p>Characteristics</p> <p>Global warming and related climate changes are predicted to significantly influence the water environment in the coming decades. There is general consensus that those changes will appear as spatial distribution and timing of rainfall, leading to increased risk of more frequent and higher intensity floods and droughts. It is predicted that a few degrees of change in temperature will directly impact the water environment to the extent that average river flows can increase in some areas by up to 40%, while in other areas, flows may decrease by up to 30%. Thus, the challenges are major and adaptation measures will have to be applied following a well prepared an adaptation policy.</p> <p>Water resources managers have long been used to dealing with monthly and annual variations. But the situation where progressing climate changes are highly likely, is new and requires a pro-active, rational adaptation policy. The building blocks for such a policy are found in IWRM as this approach seeks to identify and achieve trade-offs between different management objectives, including environmental sustainability, economic efficiency and social equity.</p> <p>Faced with climate change, an adaptation policy has to consider the multi-sectoral aspects during preparation of the appropriate responses, so as to provide water security for the productive and non-productive sectors. These include for instance agriculture, hydropower, industry, domestic use as well as environmental and ecosystem use. Likewise the policy has to guide the responses to increases in severity of extreme events such as floods and droughts. A policy also has to guide the selection of appropriate responses and interventions, set priorities of these interventions and outline how these interventions may be implemented. The policy will seek adaptive and "no-regret" interventions due to uncertainties involved. The adaptive responses are interventions that can be changed/adjusted marginally and in step with climate changes and can closely follow the dynamic development of the situation. "No-regret" interventions are those measures that turn out to be of benefit no matter how or if the predicted climate change impacts materialize.</p> <p>A policy also has to prioritize and strike a balance between "soft interventions" and "hard interventions". The soft interventions are those that deal with development of institutions and human resources aiming to build capacity to address the climate change impacts. Flood warning systems and emergency preparedness are among the soft interventions. The "hard interventions" include infrastructural elements such as dams, floodwalls and dikes. The financial situation of the nation will influence the choices and balances between "soft" and "hard" interventions</p> <p>Lessons</p> <p>Although the experience in developing policies for climate change adaptation that build on better water resources management is still in its infancy, more successful policies are known to deal with:</p> <ul style="list-style-type: none"> • Strengthening of water resources institutions accumulating information and capacity to predict, plan and cope with present and future climate changes and building up long-term resilience • Improvements in the integration of land and water management • Interventions and actions that take into account the multi-sectoral aspects of water use, conservation and protection as well as the adaptation potential and the "no-regret" character of the intervention • Frameworks for climate change adaptation at all levels from projects to communities and river basins to nations • The need for sound science and best practices as foundation for adaptation decisions; also improving and sharing knowledge and information and building comprehensive and sustainable data collection and monitoring systems • The prioritization and balancing between "soft" interventions and "hard" interventions • The balance between the social equity, the economic efficiency and the environmental sustainability • Preference for marginal changes rather than fundamental changes in development paths • Flood plain zoning, relocation and planned migration
26	Impacts of Climate Change and Human Activities on Groundwater Resources	UNESCO / IWLEARN ppt for MENARID	GW	External Link	<p>The presentation covers:</p> <ul style="list-style-type: none"> • Global Change / Climate Change • Impacts of Climate Change on (ground)water resources • UNESCO's GRAPHIC project <p>Role of groundwater for adaptation to the impacts of climate change</p>

No.	Title	Source	Reference Typology	Location	Summary
27	Climate Change Adaptation: The Pivotal Role of Water	UN-Water Policy Brief	PG	Download Here External Link	<p>Water is the primary medium through which climate change influences Earth's ecosystem and thus the livelihood and well-being of societies. Higher temperatures and changes in extreme weather conditions are projected to affect availability and distribution of rainfall, snowmelt, river flows and groundwater, and further deteriorate water quality. The poor, who are the most vulnerable, are likely to be adversely affected.</p> <p>Water stress is already high, particularly in many developing countries; improved management is critical to ensure sustainable development. Water resources management affects almost all aspects of the economy, in particular health, food production and security; domestic water supply and sanitation; energy and industry; and environmental sustainability. If addressed inadequately, management of water resources will jeopardize progress on poverty reduction targets and sustainable development in all economic, social and environmental dimensions.</p> <p>Adaptation to climate change is closely linked to water and its role in sustainable development. To recognize this reality and to respond accordingly presents development opportunities. Various necessary adaptation measures that deal with climate variability and build upon existing land and water management practices have the potential to create resilience to climate change and to enhance water security and thus directly contribute to development. Innovative technological practices and implementation of strategies are also needed at the appropriate levels for adaptation as well as for mitigation.</p> <p>Adaptation to climate change is urgent. Water plays a pivotal role in it, but the political world has yet to recognize this notion. As a consequence, adaptation measures in water management are often underrepresented in national plans or in international investment portfolios. Therefore, significant investments and policy shifts are needed. These should be guided by the following principles:</p> <ul style="list-style-type: none"> • Mainstream adaptations within the broader development context; • Strengthen governance and improve water management; • Improve and share knowledge and information on climate and adaptation measures, and invest in data collection; • Build long-term resilience through stronger institutions, and invest in infrastructure and in well functioning ecosystems; • Invest in cost-effective and adaptive water management as well as technology transfer; • Leverage additional funds through both increased national budgetary allocations and innovative funding mechanisms for adaptation in water management. <p>Application of these principles would require joint efforts and local-to-global collaboration among sectoral, multi-sectoral as well as multidisciplinary institutions.</p> <p>Responding to the challenges of climate change impacts on water resources requires adaptation strategies at the local, regional, national and global levels. Countries are being urged to improve and consolidate their water resources management systems and to identify and implement "no regrets" strategies, which have positive development outcomes that are resilient to climate change.</p>

No.	Title	Source	Reference Typology	Location	Summary
28	Water and climate change: understanding the risks and making climate-smart investment decisions	World Bank	PG	Download Here External Link	Climate change is real, and taking prudent measures to plan for and adapt to climate change must become an integral part of the Bank's water practice. There is now ample evidence that increased hydrologic variability and change in climate has and will continue have a profound impact on the water sector through the hydrologic cycle, water availability, water demand, and water allocation at the global, regional, basin, and local levels. This report and the analytical work leading to it are focused on key topics related to the impact of climate change on the water cycle and water investments. This report contributes to the World Bank agenda on climate change and more specifically, informs the water sector investments on climate issues and climate-smart adaptation options. Using the existing knowledge and additional analysis commissioned. The report illustrates that climate change is affecting the hydrologic cycle and the projected future hydrology will have a direct impact on the water resources base availability, usage, and management. Depending on the type of the water investment, this impact can be positive, negative, or neutral. The report addresses the stress on and vulnerability of the water systems through use of reliability, resilience, and robustness as the key indicators of sensitivity of water systems for climate induced failure. Current practices in the sector are examined in order to better understand the state-of-the-science for incorporating current and future variability and change in hydrology and climate in the Bank's portfolio for project planning and design. New and innovative practices taking into account adaptation options for water systems and risk-based decision making in water investments are reviewed and assessed for application to investments in infrastructure. The climate change dimension is placed within the context of the impact of other factors (within and outside the sector) such as population growth (and associated increase in demand) and land management (particularly as related to water), which in some cases may be far more significant and critical than that of climate change in some parts of the world. Finally, recommendations for a progressive agenda on water and climate change are made
29	Climate and lake impacts in Europe (EU-CLIME)	EU FP 5	WP	External Link 1 External Link 2	In CLIME a suite of Bayesian networks for climate impacts on lakes and a web-based information system (IS) for the project and for dissemination of its results. On server side the system had a database for various types of data and on client side the system had interactive web pages for modeling support and running the Bayesian networks.
30	Integrated project to evaluate the impacts of global change on European freshwater ecosystems, Euro-limpacs, EU Framework 6)	EU FP6	WP PG RI LA	External Link	Euro-limpacs was an EU funded Framework 6 project concerned with the effects of climate change on freshwater systems (rivers, streams, lakes and wetlands). In particular the Project sought to understand the effects on these vulnerable ecosystems of the interactions between changing climate and other potentially damaging processes caused by changes in the physical characteristics of rivers, nutrient pollution, acidification and the deposition of toxic metals and organic pollutants. Euro-limpacs examined how these multiple effects impact on efforts to manage freshwater ecosystems, in particular the implication for meeting the requirements of legislation such as the Water Framework Directive and Habitats Directive. The Project finished in January 2009 after 5 years. REFRESH builds on the improved scientific understanding generated in Euro-limpacs to enable the successful implementation of adaptation strategies to combat the deleterious effects of climate change on freshwater ecosystems
31	Adaptive Strategies to Mitigate the Impact of Climate Change on European Freshwater Ecosystems	EU FP 6	WP PG	External Link	The key objective of REFRESH is to develop a framework that will enable water managers to design cost-effective restoration programmes for freshwater ecosystems. This will account for the expected future impacts of climate change and land-use. REFRESH will evaluate a series of specific adaptive measures that might be taken to minimize adverse consequences of climate change on freshwater quantity, quality and biodiversity. The focus is on three principal climate-related and interacting pressures; i) increasing temperature; ii) changes in water levels and flow regimes; and iii) excess nutrients.

No.	Title	Source	Reference Typology	Location	Summary
32	Guide to Environmental Mainstreaming	IIED (International Institute for Environment and Development)	WP	External Link	IIED has now developed a First Rough Draft of a "Guide to Environmental Mainstreaming". Part 1 of this guide analyze the contextual issues (e.g. drivers and constraints) and institutional dimensions issues that frame environmental mainstreaming and provides a perspective on the key challenges. Part 2 discusses the broad range of mainstreaming approaches and tools that are best suited to particular challenges and decision-making tasks and provides guidance on when particular approaches might best be used. It also contains profiles of selected key approaches/tools to environmental mainstreaming. These are focused on those that are likely to be applicable in most countries and situations because they are legislative requirements, proven standard practice, and/or of broad applicability.
33	Mainstreaming Climate Change in National Development Processes and UN Country Programming	UNDP	WP PG	External Link	UNDP provides policy and capacity development services on climate change to support developing countries to respond to climate change impacts and to integrate climate risks into national planning and UN programming. Through these services, UNDP supports national and sub-national governments to transform their development path to a low-emission and ecologically sustainable future. Mainstreaming (or integrating) climate change in planning and decision-making processes is a crucial tool to ensure climate change adaptation and poverty reduction are implemented hand-in-hand. This approach involves taking into account risks and opportunities while putting in place adaptation measures that are attuned to the long-term vision of development. Mainstreaming climate change into national policies, plans, and development projects contributes to: <ul style="list-style-type: none"> • reducing vulnerability to climate impacts and variability • increasing the adaptive capacity of communities and national activities facing climate impacts, and • ensuring sustainable development and avoiding decisions that will generate maladaptation.
34	Anticipated Impact of Climate Change in the Caucasian Region	UNDP/GEF Kura-Aras Project	RI	External Link 1 External Link 2	UNDP/GEF Kura Aras Project presentations within 'IWRM Academy' providing overview of climate change understanding and impacts in the basin. Specific presentations prepared for each basin country based on material prepared for a basin-wide assessment of climate change building on the second national communication to UNFCCC.
35	EU Water Framework Directive Guidance document: RIVER BASIN MANAGEMENT IN A CHANGING CLIMATE	EU	PG GT	Download Here External Link	In the context of the WFD Common Implementation Strategy, an activity on Climate Change and Water was initiated in 2007 to produce guidance on how Member States should incorporate consideration of climate variability and change into the implementation of EU water policy. In 2008, the Water Directors discussed and agreed key policy messages on Climate Change and Water. ¹ These focused on the following topics: <ul style="list-style-type: none"> - EU water legislation and its ability to allow and support adaptation to climate change. - The importance of integration with other policies. - WFD and objective setting under a changing climate. - How adaptation is addressed in the 1st RBMPs. - The role of adaptation in the 2nd and 3rd river basin management cycles. This EU guidance builds upon these policy messages and is a mentioned as a priority action in the EC's White Paper on Adapting to Climate Change (2009). It has been discussed with a wide range of stakeholders and experts in the framework of the Common Implementation Strategy, and it reflects the important role of water managers in adapting to climate change. This guidance intends to give support to river basin managers in incorporating climate change in the next river basin management cycles. Further work may be needed and will be undertaken in the Common Implementation Strategy.

No.	Title	Source	Reference Typology	Location	Summary
36	Considerations for a Climate Change Monitoring Network in Rivers and Streams	US EPA	GT	Download Here External Link	PPT on developing monitoring networks for rivers to detect impacts of change from climate change
37	Climate Resilience for Catchment Methods Guidance Tool	UK EA	GT	Download Here External Link	<p>This Guidance Tool allows practitioners to assess the likely resilience of river basin management measures to future climate conditions, providing quick and easy access to the climate resilience score of river basin management measures.</p> <p>Why would I need this Guidance Tool?</p> <p>A large range of catchment measures can be implemented or considered for river basin management in order to help you achieve the objectives of the Water Framework Directive.</p> <p>This tool will help you:</p> <ul style="list-style-type: none"> • Understand how resilient measures are to changes in temperature and rainfall due to climate change. • Establish which measures are most likely to help reduce the more harmful effects of climate change on the hydrological cycle. • Implement appropriate adaptation responses within catchment management. <p>The Guidance Tool is free to download. The download of the EA Climate Resilience of Catchment Methods Guidance Tool zip file places all the files necessary to use the tool in a directory. Please refer to the 'Read me' file first and be aware that on opening the main "GUIDANCE DOCUMENT" in Microsoft Excel, you will need to ensure macros are enabled. An icon is not created in the windows Start Menu or included on the desktop. Please note the information supplied in the zip file is for guidance purposes only and is not intended to fully substitute for professional advice. The user is responsible for interpretation and use of information from the Guidance Tool and for any commercial decisions taken based on any of the outputs. Cascade Consulting excludes liability, to the fullest extent permitted by law for any direct, indirect or consequential loss, damage, costs or expenses in any way caused by the downloading of this file.</p>
38	Guidance on using the Wetland Toolkit for Climate Change. A contribution to the Wetland Vision Partnership.	CEH/ UK EA	GT WT	Download Here External Link	<p>This report provides guidance on how to use the Wetland Toolkit for Climate Change. More specifically, it guides the user in the application of tools developed to assess how climate change in the 2050s (2041-2070) might impact on wetland ecohydrology in England and Wales. The term ecohydrology is used because we have focused on the ecological and archaeological impacts of climate change through alteration of the freshwater hydrological cycle. For example, the tools do not cover any direct impacts of temperature or carbon dioxide changes on vegetation growth. The tools also exclude coastal wetlands that might be impacted through sea-level rise as a result of climate change; though such effects should be taken into account where relevant.</p> <p>This guidance and the tools it supports are designed to be used by anyone concerned with the impacts of climate change on wetlands. It is anticipated that the main users will be site managers concerned with the eco-hydrological status of their wetlands. However, it will also be useful for broader scale river corridor analysis, river basin planning, local interests and academic studies.</p>
39	ICPDR Strategy on Adaptation to Climate Change	ICPDR	AM PG GT RI WT GW	Download Here External Link	This strategy was developed to assist the Danube River Basin Countries meet the needs of the EU Water Framework Directive and the Danube River Basin Management Plan. The Strategy was developed on the basis of expert collaboration in reviewing the climate change scenarios for the basin (including temperature, precipitation extreme events) and evaluating the potential impacts across the basin. The Strategy also presents an approach for dealing with uncertainty in the estimates.

No.	Title	Source	Reference Typology	Location	Summary
40	Kura - Aras River Basin (UNDP/GEF)	UNDP/GEF	PG RI	Download Here	TDA
41	Tisza River Basin (UNDP/GEF)	ICPDR UNDP/GEF	PG AM RI WT GW	External Link	<p>UNDP has been supporting an international initiative to develop an integrated river basin management plan for the Tisza River Basin to address problems of pollution, floods and droughts to assist the countries of the basin improve their shared environment and livelihoods. Over the last 150 years, most of the natural wetlands and floodplains within the Tisza River Basin have been lost through land reclamation for agriculture or developments or flood defence schemes. These natural riverine features offer multiple benefits such as retaining harmful levels of nutrient pollution, buffering floodwaters and improving biodiversity. By developing an integrated management plan, linking issues of land and water management together with concerns of water quantity and quality, the countries are better equipped to address regional issues affecting the river and developing approaches to mitigate the impacts of varying climate and extreme events. For too long the often competing requirements of land management (agriculture, forestry, urban development) have not been involved in helping to develop and implement strategies for water management – which in return can lead, for example, to reduced flood damage to economically and socially important areas.</p> <p>The management plan was developed by the five Tisza countries in collaboration with UNDP, the GEF, European Union, Carpathian Convention and the International Commission for the Protection of the Danube River. It has assessed all the main problems in the basin and made recommendations – including the concept of making space for water leading to the restoration of wetlands and floodplains. The development of the plan adopted an innovative approach involving both top-down (ministry experts) and bottom-up (local communities) working across the five countries to develop and test new concepts to land and water management leading to improved environment for the population of the whole basin.</p> <p>The management plan has been endorsed by ministers from the Tisza counties at a recent meeting in Uzghorod (Ukraine) with the on-going challenge of implementing the demanding expectations of the plan and the citizens of the region.</p> <p>UNDP, in collaboration with the GEF, has been working in the Tisza River Basin (the largest tributary of the Danube River) for 20 years.</p>
42	Groundwater Resources Assessment under the Pressures of Humanity and Climate Change (GRAPHIC)	UNESCO	WP GD GW	Download Here External Link to Portal External Link to Brochure	<p>GRAPHIC is a UNESCO-led project, seeking to improve our understanding of how groundwater interacts within the global water cycle, how it supports ecosystems and humankind and, in turn, responds to complex and coupled pressures of human activity and climate change. GRAPHIC was developed to successfully achieve these objectives within a global context and represents a collaborative effort that serves as an umbrella for international research and education.</p> <p>Through a variety of case studies, GRAPHIC outlines areas of international research, covering major geographical regions, groundwater resource topics, and methods to help advance the knowledge required to address both the scientific and social aspects of this field. GRAPHIC promotes and advances sustainable groundwater management considering projected climate change and linked human effects.</p> <p>GRAPHIC provides a platform for the exchange of information through case studies, thematic working groups, scientific research, and communication.</p> <p>GRAPHIC serves the global community by providing scientifically-based and policy-relevant recommendations.</p> <p>GRAPHIC uses regional and global networks to improve the capacity to manage groundwater resources.</p>

No.	Title	Source	Reference Typology	Location	Summary
43	UNFCCC bibliography on mainstreaming climate change	UNFCCC	WP	Download Here External Link	<p>Bibliography of information sources on: Mainstreaming climate change addressing:</p> <ul style="list-style-type: none"> • Policy issues related to climate change mainstreaming • Practical guidance to mainstreaming climate change • Experience in mainstreaming climate change <p>Mainstreaming adaptation to climate change:</p> <ul style="list-style-type: none"> • Policy issues related to mainstreaming adaptation to climate change • Practical guidance to mainstreaming adaptation to climate change • Experiences in mainstreaming adaptation to climate change <p>Mainstreaming climate change at the sectoral level</p> <ul style="list-style-type: none"> • Agriculture • Water • Food security • Coastal zones
44	Global Historic Climatological Network (CHCN)	NOAA (USA)	WP DS GT	External Link	<p>GHCN (Global Historical Climatology Network)-Daily is an integrated database of daily climate summaries from land surface stations across the globe. GHCN-Daily is comprised of daily climate records from numerous sources that have been integrated and subjected to a common suite of quality assurance reviews.</p> <p>GHCN-Daily now contains records from over 75000 stations in 180 countries and territories. Numerous daily variables are provided, including maximum and minimum temperature, total daily precipitation, snowfall, and snow depth; however, about two thirds of the stations report precipitation only. Both the record length and period of record vary by station and cover intervals ranging from less than year to more than 175 years.</p> <p>The dataset is regularly reconstructed (usually every weekend) from its 20-plus data source components to ensure that GHCN-Daily is generally in sync with its growing list of constituent sources. During this process, quality assurance checks are applied to the full dataset. On most weekdays, GHCN-Daily station data are updated when possible from a variety of data streams, which also undergo a suite of quality checks.</p>
45	Global Change Master Directory	NASA	WP DS GT	External Link	A web portal offering Global Data Sets and tools
46	NASA Goddard Institute for Space Studies (GISS)	NASA	WP DS GT	External Link	A web portal offering data sets, tools and other sources of information (e.g. climate change simulations, earth observations, climate drivers, etc.)
47	IPPC Data Distribution Centre	IPPC	WP DS GT	External Link	A web portal offering links to models and data
48	UNDP Climate profiles (hosted through University of Oxford, UK)	UNDP	WP DS GT	External Link	<p>These country-level climate data summaries are intended to address the climate change information gap for developing countries by making use of existing climate data to generate a series of country-level studies of climate observations and the multi-model projections made available through the WCRP CMIP3. A consistent approach has been applied for 52 developing countries in order to produce an 'off the shelf' analysis of climate data, and also make available the underlying data for each country for use in further research.</p> <p>For each of the 52 countries, a report contains a set of maps and diagrams demonstrating the observed and projected climates of that country as country average time series as well as maps depicting changes on a 2.5° grid and summary tables of the data. A narrative summarizes the data in the figures, and placing it in the context of the country's general climate.</p>



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