

## Section 1

# Overview of IRWM Planning and Climate Change

Climate change is affecting California in many ways, several of which impact our water resources: sea levels are rising, snowpack is decreasing, and water temperatures are increasing. In the future, droughts are expected to become more frequent and more severe, and storm intensities are expected to increase. These changes affect our ability to meet crucial water management objectives such as ensuring reliable water supply and quality, managing floods, and protecting ecosystem functions and critical habitats. Water resource planners need ways to integrate climate change considerations into decisions and planning processes, today and in years to come. Integrated regional water planning is an excellent framework for addressing water-related climate impacts, as it provides a process for stakeholders with varied water-related priorities to work together to develop solutions that satisfy all water uses and needs. Because climate change impacts so many aspects of water resources, this process is ideal for addressing adaptation to climate change and for developing measures to help mitigate future climate change.

Planning for climate change can be viewed as a process of assessing risks related to climate change, evaluating and selecting strategies that appear most effective based on current knowledge, and monitoring conditions and updating strategies as knowledge improves. This handbook outlines a process for accomplishing this in the context of regional water management.

The process outlined in this handbook allows regional water management planners to conduct the necessary analyses to assess risks and possible climate change impacts. It also informs decisions concerning possible future actions. A climate change impact assessment may indicate that immediate action is required to avert unacceptable impacts or threats, even though analysis indicates that those threats may not become critical for several years. Using the results of the assessment, regional water planners will be able to prioritize resource management strategies to best serve their region. Box 1-1 provides two examples of climate change assessment results and likely actions that would follow such assessments.

Adapting to climate change impacts continues to be an ongoing process, becoming more adaptable over time is critical to addressing to climate change. This includes improving information accessibility and monitoring systems, and working together across institutional and social boundaries to leverage resources from diverse sources (National Academy of Sciences 2010a).

### Examples of Climate Change Assessment Results and Likely Actions

- 1) *Relatively high risk in near future:* The assessment identifies ways in which climate change is leading to significant consequences for water supply, quality, flooding, or other management objectives. This knowledge can help water managers adjust management strategies in ways that can reduce these impacts. For example, a coastal region might take steps to promote wetlands restoration in low-lying areas where the consequences of inundation due to sea level rise would be significant. Ongoing monitoring of sea level rise, along with the effectiveness of wetlands restoration efforts, would then be critical for informing future decisions.
- 2) *Longer-term and more uncertain risks:* The assessment identifies future impacts of climate change that do not appear significant now but may become so in the future, or that may be important now but uncertainty is high. In these cases, decision makers might want to identify strategies that would provide measurable benefits today while also reducing vulnerability to these possible impacts (so-called “no-regrets” strategies). For example, increased storm intensity is possible under climate change, although evidence of this in California is currently limited. However, floodplain restoration can help reduce flood impacts today, as well as protect critical habitats. If “no-regrets” strategies don’t exist, then ongoing monitoring could be undertaken to enable a more informed decision at a later date.

#### Box 1-1

The Integrated Regional Water Management (IRWM) planning is a well defined and clearly articulated process that addresses watershed management in California. The IRWM planning process provides a mechanism for stakeholders to work together to identify and address the challenges that potentially exist among multiple planning efforts. The IRWM planning process also provides a means to develop and update water management objectives to address a region’s water resources management challenges, overcome potential water management constraints, and implement water management projects and programs. In this regard, the IRWM process provides an excellent foundation to address potential climate change impacts on water resources. As such, it will be used as a model for this handbook.

The IRWM Planning Act (California Water Code Section 10530 et seq) directs the California Department of Water Resources (DWR) in defining components required in an IRWMP in California. DWR’s guidelines for IRWMPs (DWR 2010a, [http://www.water.ca.gov/irwm/docs/Guidelines/Prop84/GL\\_Final\\_07\\_20\\_10.pdf](http://www.water.ca.gov/irwm/docs/Guidelines/Prop84/GL_Final_07_20_10.pdf)) include many planning standards, including climate change considerations. This handbook provides broad guidance to water resources planners on how to incorporate climate change analyses into regional water planning processes using the IRWM planning process as a model. This handbook outlines the necessary steps to incorporate analysis of climate change in the regional water planning process, reviews actions that various agencies and planning entities are currently taking with respect to climate change,

*Because each planning region has a unique environmental setting, set of resources to manage, and prioritization of management objectives, there is no single “correct” approach to either identifying climate change impacts or to adapting to them.*

and provides guidance for developing regionally specific strategies for addressing climate change impacts in any regional or watershed level planning process (see Box 1-2).

## 1.1 Using this Handbook

The purpose of this handbook is to provide a roadmap for water resources planners describing:

1. Recommended steps for including climate change impacts and adaptation in planning strategies,
2. Recommended steps to assess system-wide and project-associated greenhouse gas (GHG) emissions and identify potential mitigation measures, and
3. A strategy for incorporating the steps identified in (1) and (2) into the IRWM process or other similar water management planning efforts.

### Role of this Handbook in IRWMP Development

In August 2010, DWR released the Propositions 84 and Proposition 1E IRWM Program Guidelines. These guidelines described the IRWM plan standards, including for the first time a climate change standard. DWR hopes that this handbook will be an important resource for those pursuing IRWM grant funding by outlining a comprehensive approach to addressing climate change. The handbook should be viewed as a tool that may provide useful assistance to IRWM planning efforts on how to address climate change issues. However, this handbook in no way supersedes, replaces, or adds scope to the Climate Change Plan Standard contained in the 2010 IRWM Program Guidelines. This handbook provides an overarching framework (using IRWM as a model for regional water planning) for how to integrate analysis of a changing climate into regional water management planning. Potential grant applicants are referred to the above-referenced IRWM Program Guidelines and associated Proposal Solicitation Packages for the specific grant application requirements.

### Box 1-2

This handbook discusses methods to qualitatively assess vulnerabilities, and quantify climate change impacts on water resources, in addition to providing examples of mitigation and adaptation measures that can be taken to reduce impacts. Several decision-support frameworks are described for including climate change in the process of developing and implementing strategies and projects for meeting the objectives of an IRWMP or similar watershed plan.

Because each region has a unique environmental setting, set of resources to manage, and prioritization of management objectives, there is no single approach to estimating climate change impacts on water resources. Specific mitigation measures (i.e. reducing GHG emissions) or adaptation measures (i.e. developing ways to live with the effects of climate change) will likely be different for each region. Therefore, this handbook presents multiple methods,

techniques, and case studies that can be useful in incorporating climate change into water resource planning based on regional vulnerabilities and objectives.

Assessing the projected impacts of climate change and attempting to plan for them involves uncertainty at nearly every step of the analysis and decision-making process. As with planning for any future condition, decisions must be made with incomplete information. Planning is an iterative process which builds on knowledge about past and current conditions to make assumptions about the future. While significant uncertainty still exists about how quickly and to what degree climate change will occur, a preponderance of the scientific evidence related to projected future climate changes compels planners to act now. It is therefore imperative that regional water planners begin to consider potential futures where temperatures have increased appreciably and precipitation patterns no longer follow the statistical distribution of past observations.

## 1.2 IRWM Planning

The IRWM planning process is intended to provide a collaborative, open, and accessible process for regional water management planning. The main objectives include:

- Improving water supply reliability,
- Protecting and improving water quality,
- Ensuring sustainability through environmental stewardship,
- Promoting multiple benefits, and
- Promoting integration and regional planning.

The IRWM process presented in Figure 1-1 provides an integrated approach for addressing water management issues within a region. The process identifies and involves water management stakeholders from a region and guides the stakeholder group through the following steps (see Figure 1-1):

- Identifying and organizing stakeholders to form a governance structure;
- Defining and describing the planning area;
- Establishing water management objectives and measurable targets for the region;



**Figure 1-1. IRWM Planning Process Summary.**

- Identifying and evaluating water management strategies applicable to the region;
- Identifying opportunities for integrating proposed regional water supply, water quality, and resource management strategies;
- Assessing the ability of the resource management strategies to meet the regional objectives;
- Establishing a system for prioritizing the strategies;
- Presenting a plan for implementing and monitoring the water management strategies; and
- Identifying a framework for overall IRWM planning in the Region, including future updates of resource management strategies and plan priorities.

The IRWM planning process provides a mechanism for stakeholders to work together to identify and address the challenges that potentially exist among multiple planning efforts. The IRWM planning process also provides a means to develop and update water management objectives to address the region's water management challenges, overcome potential water management constraints, and implement water management projects and programs. Given that climate change will impact all aspects of regional water management to some degree, the IRWM process provides an excellent forum to address potential climate change impacts on water resources.

The IRWM program guidelines (DWR 2010a) includes 16 standards that are recommended for the planning process. These standards are related to the IRWM planning process in Figure 1-2. Some of the standards, such as regional description, correspond with specific portions of the planning process. Other standards, such as stakeholder involvement, are more thematic standards that are relevant to multiple parts of the IRWM process. Climate change is one of these thematic standards.

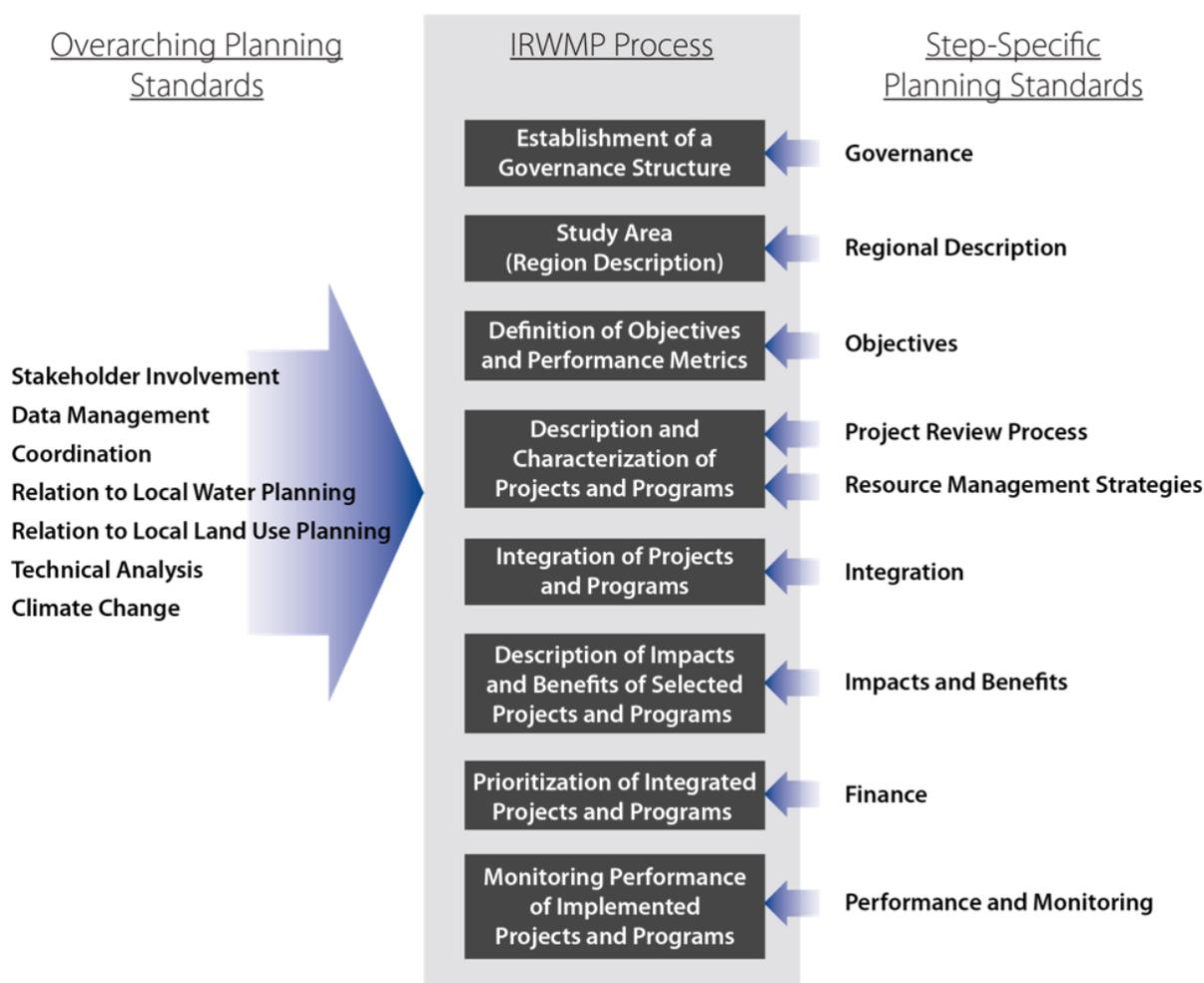


Figure 1-2: The IRWM Planning Process as it Relates to the IRWM Standards.

### 1.3 Linking Climate Change to IRWM Planning

Given the measured and projected climate change impacts on water resources, many local, regional, state, and national agencies around the world are starting to plan for climate change. Water resources management can play a significant role in mitigating future impacts of climate change by reducing GHG emissions. In addition, water resources projects need to be resilient or adapt to those climate change impacts that are unavoidable and, in some cases, already being observed. Climate change can impact, and is already impacting, water quality, aquatic life, water supplies, and water demands in California and globally. In California, droughts and floods are expected to be more frequent in the future, and average annual Sierra Nevada snowpack storage is expected to decrease. Many of the potential and observed impacts from climate change on water resources are depicted in Figure 1-3. This handbook discusses the role of water resources planning in both mitigation and adaptation strategies.

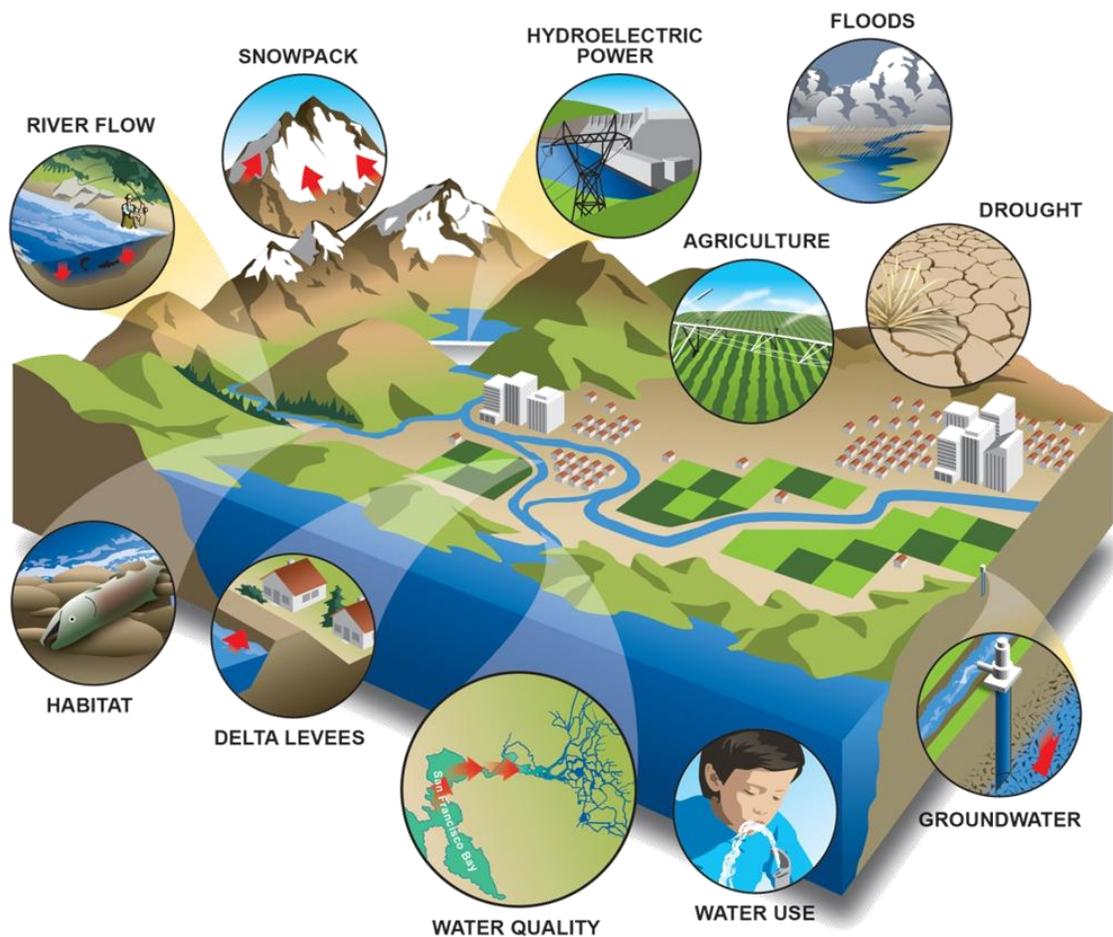


Figure 1-3: Potential and Observed Climate Change Impacts on Water Resources in California.

Source: <http://www.water.ca.gov/climatechange/cc101.cfm>

### 1.3.1 Evaluating the Water-Energy Relationship and Greenhouse Gas Emissions in the Planning Process

The relationship between water and energy is complex. Approximately one-fifth of California's electricity is generated by hydropower, while approximately one-fifth of the state's electricity and 30% of the state's non-power plant natural gas<sup>1</sup> is used for conveyance, treatment, distribution, and end use of water (Climate Action Team (CAT 2008). Therefore, increases in water use efficiency translate can into energy use reduction and reductions in GHG emissions. Consideration of energy and water use as part of project evaluation is critical to

**Mitigation:** Human interventions to reduce the sources of greenhouse gases or enhance the sinks that remove them from the atmosphere.

--- US Climate Change Science Program (CCSP) 2009

<sup>1</sup> Non-power plant natural gas is natural gas that is not used to generate electricity, but is used to provide directly used energy; for example, to heat boilers and water heaters.

reducing GHG emissions. Each molecule of CO<sub>2</sub> emitted to the atmosphere will enhance global warming for approximately a century (Intergovernmental Panel on Climate Change (IPCC) 2003); therefore, efforts to reduce GHG emissions to the atmosphere will reduce future impacts of climate change and are referred to as climate change mitigation.

Selection between alternative projects designed to address the same objective may yield significantly different GHG emissions. For example, a desalinization plant and a water transfer program designed to increase water supply reliability may require vastly different energy inputs. In addition, GHG emissions for water projects can be reduced in several ways, including reduction in water use, efficient design of facilities, energy efficiency for operations, and incorporation of renewable energy. Quantitative methods for evaluating GHG emissions for water resources projects are discussed in Section 3. Incorporation of GHG emissions into other planning objectives to evaluate potential projects is discussed in Section 6.

### 1.3.2 Completing A Climate Change Adaptation Analysis

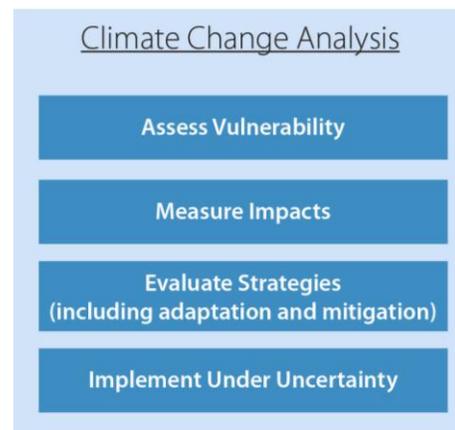
Climate change has the potential to impact water demand, water supply, flood management, water quality, aquatic ecosystems, sea level rise, and hydroelectric resources. In some areas of the U.S., including California, the impacts of climate change on water resources are already being detected; it is expected that more prominent impacts will be seen within the next 20 to 50 years.

This handbook outlines a four-step process for completing a climate change adaptation analysis: (1) Assess Vulnerability, (2) Measure Impacts, (3) Develop and Evaluate Strategies, and (4) Implement Under Uncertainty. Figure 1-4 depicts the steps described below:

- **Assess Vulnerability**: Identify the region-specific water resources (including source areas for imported water) that are potentially vulnerable to climate change in a way that is both significant for the stakeholders involved and measureable in some way. Section 4 provides guidance for regional planners on assessing the vulnerability of a region to climate change.

**Adaptation:** *Adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which minimize harm or take advantage of beneficial opportunities.*

--- IPCC 2011



**Figure 1-4: Climate Change Adaptation Assessment.**

- ***Measure Impacts:*** To the extent appropriate, quantify the climate change impacts to a region's most vulnerable water resources. This step can be highly analytical or qualitative, depending on the estimated level of vulnerability and system, operational complexity, and resources available for the analysis. Section 5 provides guidance for how to measure the potential impacts of climate change on a region's resources.
- ***Evaluate Strategies:*** Compare and rank existing and potential resource management strategies based on their effectiveness in mitigating and adapting to climate change impacts. New potential projects or programs may be identified during this step of the process. Evaluating strategies for climate change adaptive capacity is an important component of the overall evaluation of individual strategies or projects, as well as integrated project portfolios, in any IRWM planning process. Section 6 provides guidance on how to incorporate climate change scenarios into the performance evaluation of regional strategies.
- ***Implement Under Uncertainty:*** Incorporate regional management strategies into a broader planning context that considers the uncertainties associated with climate change. This can be done in many ways, for example using approaches based on adaptive management, robust decision making, and other decision-support methods. Uncertainty influences every step of a planning process involving climate change, including methods for climate change impact measurement, project selection, implementation, and performance monitoring. Section 7 presents general guidance on specific methods to incorporate uncertainty into the IRWM planning process.

There is no standard method for assessing potential climate change impacts and adaptive capacity. This handbook attempts to comprehensively discuss methods that have been used by different planning agencies. Methods discussed in this handbook must be tailored to the unique characteristics of each region.

This handbook focuses on California-specific climate change legislation and data synthesis and availability. The legislative requirements, data, and methods discussed focus on California climate change issues. However, many parts of the U.S. and the world face similar uncertainties and vulnerabilities due to climate change. Examples are provided in this handbook from studies conducted outside of California, and the methods discussed in this handbook to measure impacts and adapt to them are also applicable to other regions.

### 1.3.3 Decision-Support Framework

The processes of planning for climate change adaptation and GHG emissions reduction naturally overlap with the IRWM planning process. Figure 1-5 presents the relationships between the primary steps in IRWM planning and climate change-related analysis.

Figure 1-5 represents linkages and interactions among the IRWM planning process, the climate change analysis process, and GHG emissions considerations. With the exception of establishing a governance structure, every step of the IRWM planning process is either informed by climate change analysis, or potentially influences how climate change is considered. These linkages are briefly described for each step of the IRWM planning process, below. In addition, the section of this handbook which describes how to perform the step is provided in brackets after the description.

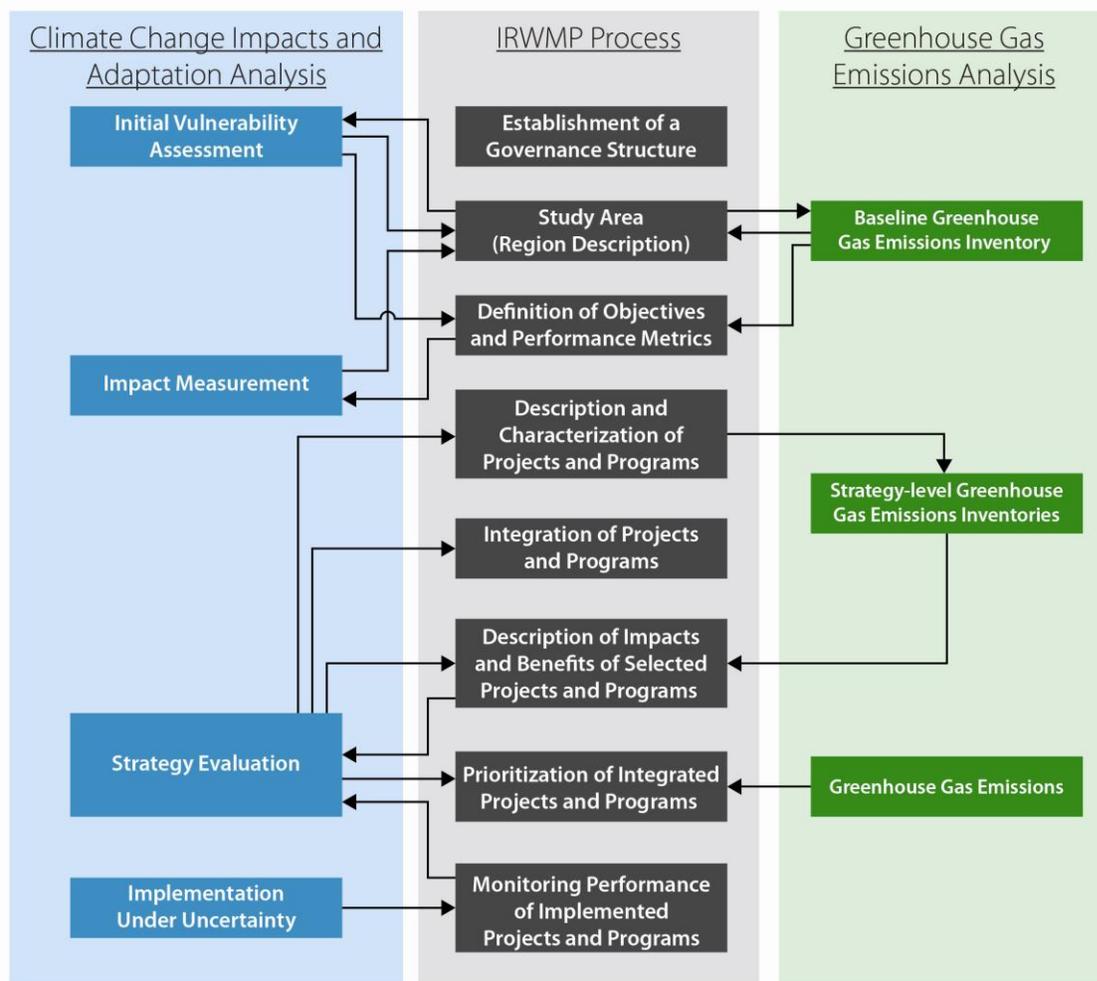


Figure 1-5: Relationship between IRWMP Process and Climate Change Analyses.

Study Area: Regional information is needed to conduct an initial qualitative climate change vulnerability assessment and to conduct a baseline GHG emissions inventory. In addition, the description of the planning region should include a discussion of qualitative potential vulnerabilities and more quantitative baseline climate change impacts (Sections 4 and 5).

Objectives and Performance Metrics: Qualitatively assessed climate change vulnerabilities and baseline GHG emissions influence the development of the overall planning objectives and more quantitative performance metrics. For those areas especially vulnerable to climate change, adaptation may become one of the objectives. Performance metrics are quantitative assessments of the degree to which an objective is achieved. The metrics developed relating to climate change can be used to measure the baseline and project-level climate change impacts (Section 4).

Description and Characterization of Projects and Programs: Quantifying the performance of resource management strategies in the future needs to take into account potential climate change. By planning for future conditions that are more challenging than current climate conditions, strategies that are more robust, resilient, and flexible can be identified. This analysis informs the sections on resource management strategies of the IRWMP (Sections 5 and 6).

Integration of Project and Programs: Many projects and programs will perform differently under different climate conditions; others may show little sensitivity to climate conditions. The synergy and interrelationships between projects can also differ when potential impacts of climate change are considered. Evaluations and integration of programs and projects under future conditions that account for potential climate change may identify important co-benefits, synergies, or tradeoffs (Section 6).

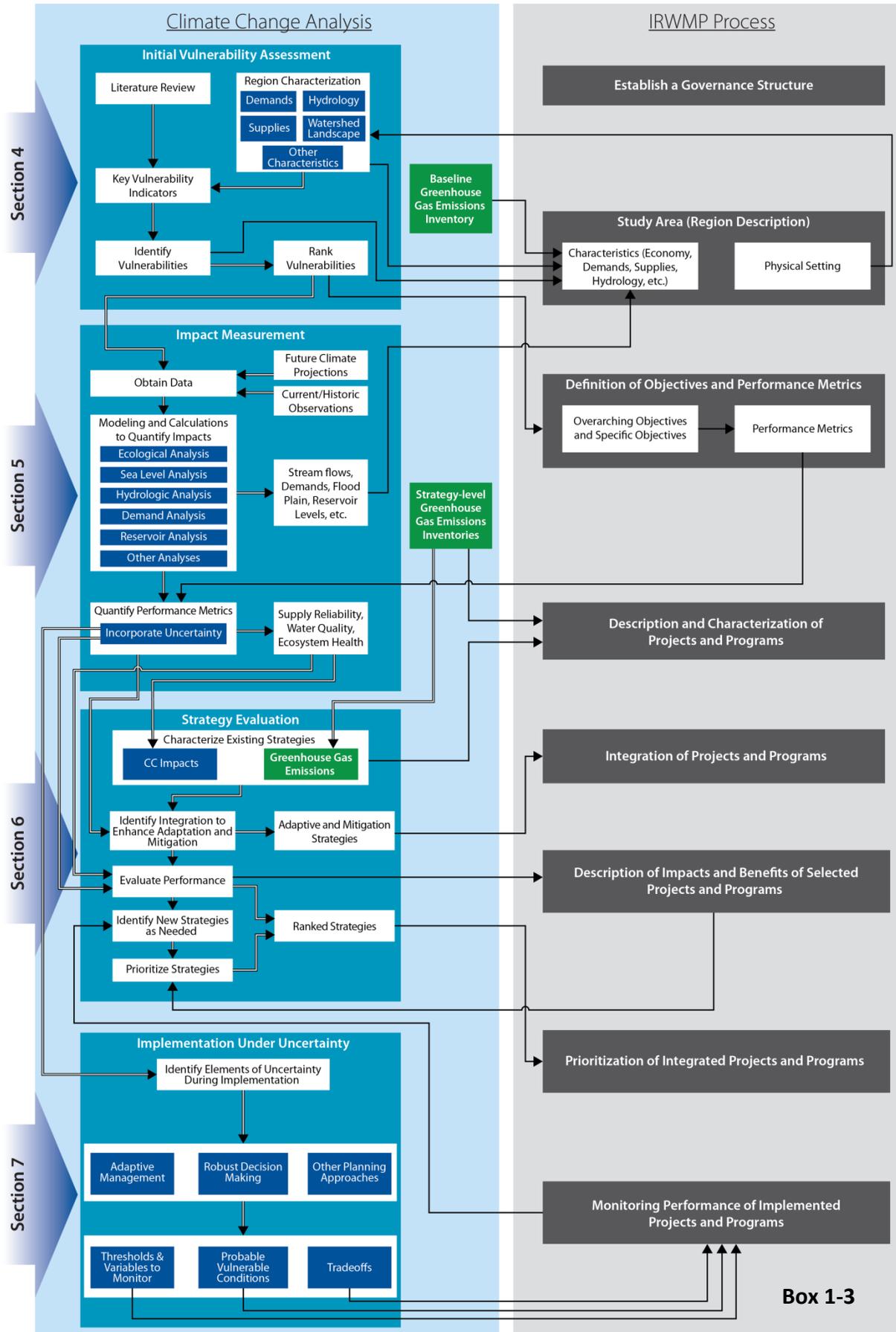
Description of Impacts and Benefits of Selected Projects and Programs: Impacts and benefits of the strategies considered in an IRWMP should be described with consideration of future conditions that account for potential impacts of climate change. The impacts and benefits help inform the decision about the best integrated strategies for the region. Impacts and benefits will typically map to specific performance measures in an IRWMP to allow decision makers to narrow down the strategies that are more beneficial. Consideration of climate change in this analysis helps gauge how each project or program will perform under a range of future climate conditions (Sections 5 and 6).

Prioritization of Integrated Projects and Programs: Prioritization of strategies should be informed by a region's vulnerability to climate change. If specific resources show high vulnerability to the potential impacts of climate change, it may warrant increasing the priority of strategies that help reduce the region's vulnerability or help the region adapt to possible change (Sections 6 and 7).

Monitoring Performance: Monitoring performance of projects and programs helps inform the selection and evaluation of future strategies and allows past projects to be modified to better meet the objectives of the region. Because of the uncertainty associated with future climate change, monitoring can play a critical role in triggering the implementation of strategies or the modification of existing operations as the specific impacts of climate change are observed (Section 7).

Box 1-3 presents a much more detailed version of the decision-support framework schematic showing the steps in the climate change analysis and their linkages to the preparation of an IRWMP. Arrows indicate where analysis of climate change impacts needs to be considered within the IRWM process, transfers of information *between* the IRWM process and climate change analysis (solid arrows), or a flow of information *within* either the IRWM process or within an analysis that incorporates climate change (piped arrows). Climate change analysis is shown as separate and distinct from the IRWM process to illustrate what is new and different. In fact, climate change analysis is really superimposed on the existing IRWM process and in the future can easily be embedded as an integral aspect of the overall planning process.

Box 1-3 also indicates sections of the handbook that discuss various steps for incorporating climate change into the analysis and project evaluation involved in an IRWMP. It is not essential to have a detailed understanding of each of the linkages included in the diagram; rather, it is important to understand how climate change may impact water resources within a planning region, and to determine the most robust way to adapt. This handbook is intended to clarify the connections in this diagram. Application of the climate change decision-support framework requires the planner to have a general understanding of the current state-of-the-art climate change science presented in the next section.



This page intentionally left blank.