

Measuring Climate Mitigation and Adaptation Expenditures in the Economy: Methodological Challenges

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Abstract

Accounting for expenditures related to climate change – both mitigation and adaptation – is becoming an increasingly important topic among policymakers and, in turn, the economic measurement community internationally. For decades, national statistical offices (NSOs) have produced accounts that disaggregate economic activity within the economy – including by industry, function, or purpose – as they provide information to policymakers and numerous other users about specific sectors or types of economic activity. For many countries, this includes measuring environmental expenditures and the environmental goods and services sector (EGSS), which follow guidelines set out in the SEEA-CF (System of Environmental-Economic Accounts – Central Framework) and use the CEA (Classification of Environmental Activities). These standards generally account for expenditures for climate change mitigation as part of environmental protection expenditures, given that these types of expenditures fit within the existing definitions of environmental protection activities (i.e., expenditures for the purposes of reducing the emissions of greenhouse gases). Climate change adaptation expenditures, on the other hand, have not been included in the SEEA-CF activities accounts; and there is currently no comprehensive standard for classifying expenditures in the economy for the purpose of climate adaptation. In this paper, we first investigate recent international work on describing and defining ‘climate change adaptation,’ such as the Working Group II report, “Climate Change 2022: Impacts, Adaption and Vulnerability,” a variety of budget tagging schemes, and other sources. Our goal is to advance the international discussion toward developing methods for defining expenditures related to climate change adaptation that would be consistent with the accounting principles in the SEEA CF and SNA. The delineation between adaptation/preparation vs. clean-up/recovery from a major natural disaster will also be discussed. Finally, we briefly outline potential paths forward for research and development of climate change mitigation and adaptation statistics in the U.S., building on recent pilot efforts in natural capital accounting more generally and environmental activity accounts more specifically.

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1 Introduction

In this paper, we examine approaches to measuring climate change adaptation and mitigation for the purposes of environmental-economic accounting. Primarily, we summarize current and prior efforts that define, identify, and develop statistics for climate change related expenditures. After describing the different aspects that have been considered by the international community, we offer a critical assessment of the current state of method and present a visual showing different interactions among these approaches.

We should note at the outset that, while there has been a groundswell of interest in this topic recently, it is not entirely new to the environmental-economic accounting community. In fact, the research agenda of the SEEA-CF included in Annex II includes the following statement which points in the direction of examining environmental protection and resource management expenditures together with climate change mitigation and adaptation, as well as, together with disaster related expenditures – preventive/adaptive or recovery.

Accounts and statistics relating to the minimization of natural hazards and the effects of climate change

A2.19 The SEEA Central Framework limits the scope of economic activities considered to be environmental to environmental protection and resource management activity. However, it is recognized that there are a number of other economic activities that are related to the environment which may be of particular interest for policy and analytical purposes (see sect. 4.2). A specific set of activities encompasses efforts to minimize the impact of natural hazards (such as floods, cyclones and bush fires) and efforts to mitigate, or adapt to, the effects of climate change.

(SEEA-CF, Annex II, pages 307-308)

A decade later, however, there is no agreed upon definition for the identification of climate change adaptation and mitigation expenditures. Neither is there a common methodology for developing statistics for climate change related expenditures. This paper attempts to evaluate current efforts critically in order to advance discussion on developing a working methodology. For example, there are a number of shortcomings or gaps in proposed approaches and related classification work – such as the absence of the human systems / natural systems in adaptation methodologies. For reasons we elaborate on more below, the human/natural systems distinction is important when considering resource management expenditures together with climate adaptation of natural systems/ecosystems.

2 IPCC Definitions of climate change adaptation and mitigation

Before examining expenditures related to climate change, we begin by first summarizing the prevailing international definitions of climate change adaptation and mitigation. One key source for these definitions is the current glossary of the Intergovernmental Panel on Climate Change (IPCC) where climate change adaptation and mitigation are defined as follows:

Adaptation

In *human systems*, the process of adjustment to actual or expected *climate* and its effects, in order to moderate harm or exploit beneficial opportunities. In *natural systems*, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects.

Mitigation (of climate change)

A human intervention to reduce emissions or enhance the *sinks* of *greenhouse gases*.

(Source: <https://apps.ipcc.ch/glossary/>)

According to these IPCC definitions, climate change mitigation is only done through “human intervention” and involves two types of actions, reducing emissions of greenhouse gases or enhancing sinks of greenhouse gases. Whereas climate change adaptation are the processes of adjustments by both natural systems and human systems.

Having identified what CC mitigation and adaptation are, we next consider what type of *expenditures* would be relevant for climate change mitigation and adaptation.

3 Definitions of Climate Change Expenditures

Currently there are no official statistical definitions of climate change adaptation expenditures or mitigation expenditures. But there are many different attempts to define these types of expenditures, some of which we will summarize and discuss in this section.

3.1 UNECE – Conference of European Statisticians (CES): Climate Change Related Statistics and SEEA-CF

The UNECE-CES work on climate change related statistics includes the development of an indicator set with 39 core indicators. If the metadata sheets for the indicators are examined, we can obtain definitions of the indicators and identify the ones that include economic data for their calculation. (<https://unece.org/statistics/publications/CES-set-of-core-climate-change-related-indicators>) The indicator set is grouped into the 5 UNFCCC themes: Drivers, Emissions, Impacts, Mitigation, and Adaptation.

There are 11 indicators from the CES indicator set that have a monetary component (see list below). In a number of the indicators, the intensity or efficiency of an activity is the indicator. This means there is a need to have the value added or production value of the economic activity in order to produce the indicator (See 5a and 13) . For the others there are more specific economic data used.

There are 3 with a focus on taxes, subsidies, and support on/for energy (31, 32, 4). There are 2 that have an economic loss due to hydro-meteorological disasters (24 and 28). There is one indicator for the average price of carbon based on permit trading (33), and one from the Paris agreement regarding the USD 100 Billion commitment (34) – but these are not national level measures, which would be problematic for developing accounts at a national level.

And finally, there are two indicators which have an expenditure focus: mitigation expenditure of the whole economy (relative to GDP) - #30 - and government adaptation expenditure (relative to GDP) - #35.

Eleven CES Climate Change Indicators that include a monetary component:

Mitigation:

- 30 *Share of climate change mitigation expenditure relative to GDP*
- 31 *Share of energy and transport related taxes as percentage of total taxes and social contributions*
- 32 *Total climate change related subsidies and similar transfers / GDP*
- 33 *Average carbon price*
- 34 *Mobilized amount of USD per year starting in 2020 accountable towards USD100 billion commitment*

Adaptation:

- 35 *Share of government adaptation expenditure to GDP*

Impacts

- 24 *Direct economic loss attributed to hydro-meteorological disasters in relation to GDP*
- 28 *Direct agricultural loss attributed to hydro-meteorological disasters*

Drivers:

- 4 *Total support for fossil fuels / GDP*
- 5a *Total energy intensity of production activities*

Emissions

- 13 *GHG emission intensity of production activities (value added)*

From this CES climate change related indicator set, two types of expenditures are included: Government adaptation expenditures and climate change mitigation expenditure. The metadata sheets reference the Classification of Environmental Activities (CEA) in the SEEA Central Framework (2012) Annex 1, SEEA-CF section 4.4, and Eurostat - SERIEE Environmental Protection Expenditure Accounts Compilation Guide.

There are no specific definitions of climate change adaptation or mitigation expenditures in the SEEA-CF. In fact, the SEEA-CF clearly states that these SEEA definitions do **not** cover expenditures for climate change adaptation (see paragraph 4.23 below) which means that the definitions of the CES indicator set are incomplete.

4.23 The collection and organization of information on activities that minimize the impact of natural hazards may be of particular interest in understanding the economic response to natural hazards and may also provide indicators of the economic impacts of changes to landscapes and water systems, including environmental changes due to climate change. While ***economic activity associated with adaptation to climate change is not considered an environmental activity*** per se, it is recognized that information on this activity may be of particular interest. (SEEA-CF, para 4.23, emphasis added)

Annex I of the SEEA-CF describes the CEA. Category 1: Protection of Ambient Air and Climate is of particular interest since it covers expenditures that,

“...comprises measures and activities aimed at the reduction of emissions into the ambient air or ambient concentrations of air pollutants as well as measures and activities aimed at the ***control of emissions of greenhouse gases*** and gases that adversely affect the stratospheric ozone layer.” (SEEA-CF, Annex 1, page 268, emphasis added)

This definition of Category 1 of CEA clearly states that climate change mitigation expenditures include “measures and activities aimed at the control of emissions of greenhouse gases.”

The monetary SEEA Accounts only define environmental protection expenditures and resource management expenditures. Although this is the case, the general interpretation of CEA Category 1 including expenditures for the Protection of Ambient Air and Climate covers the mitigation/reduction of greenhouse gas emissions and is typically being used as the default “climate mitigation” expenditures definition.

The definitions above and scope in the SEEA-CF require that climate change adaptation expenditures to be outside of expenditures in the environmental activity accounts as currently constructed. Countries that develop a full set of environmental activity accounts following the standards set out in SEEA-CF would therefore have to supplement their accounts with a separate account that stands outside the current international standard. This is not necessarily unusual, as many countries (including the U.S.) produce satellite accounts that track environmental-related economic activity that falls outside the scope of a particular SEEA account (e.g., U.S. satellite accounts for the Marine Economy or for Outdoor Recreation).

3.2 Eurostat

Three work areas at Eurostat have been identified that are directly relevant to the classification and identification of climate change expenditures, (1) Environmental protection expenditures (EPE) and resource management expenditures and statistics, (2) the Eurostat webpage for climate change statistics, and (3) a project to delineate climate change mitigation and adaptation activities in the industry classification (NACE) and product classification (PRODCOM) for developing CC mitigation and CC adaptation sectors using an approach that is similar to the work to establish the Environmental Goods and Services Sector (EGSS).

(1) Environmental protection expenditures (EPE) and resource management expenditures and statistics

Eurostat has a number of required statistical reporting for members of the European Statistical System regarding their environmental monetary accounts –including the reporting of environmental protection (EPE) and resource management (RM) expenditures. But what is the relationship between these EPE/RM expenditures and Climate Change related expenditures?

Some countries collect and publish the figures for CEA category 1 as two sub-categories where one sub-category is solely related to expenditures of the reduction of greenhouse gas (GHG) emissions. See for example, Statistics Norway’s Statbank Table 13062 Environmental Protection Expenditure where the environmental area, “Greenhouse gases” can be selected (<https://www.ssb.no/en/statbank/table/13062>). These statistics are only available in the countries that have made a separate sub-category focusing on the expenditures of enterprises related to the reduction of GHG emissions to the atmosphere. For reporting to Eurostat these separate GHG-reduction expenditures are not required reporting, only reporting to the entire CEA category 1, “Protection of ambient air and climate” is required.

(2) Eurostat webpage for climate change statistics

In addition to the EPE/RM statistics, Eurostat has also developed a webpage specific to climate change (<https://ec.europa.eu/eurostat/web/climate-change>) where they assemble a variety of relevant statistics. On this webpage Eurostat states that,

Climate change **mitigation** refers to activities undertaken to reduce or offset GHG emissions. Climate change **adaptation** includes specific actions to help communities and ecosystems better cope with, or even benefit from, climate change.

From this we see that Eurostat has expanded the SEEA-CF and CEA definition of ‘mitigation activities’ to include both reducing *and offsetting* GHG emissions. It is unclear whether this expansion is included in the Environmental Protection Expenditure Accounts and underlying statistics.

We also see that Eurostat has identified that climate change adaptation includes specific actions to help ecosystems recover and better cope with climate change. This would mean that many of the resource management expenditures already included in the resource management/ecosystem expenditure statistics could also be considered climate change adaptation expenditures. It would appear that the EPE/RM statistics should cover CC mitigation and adaptation expenditures related to natural systems although the current CEA classification structure does not always allow for these CC expenditures to be clearly separated from other EPE/RM activities.

Thus, we are left primarily with an open question regarding the definition of climate change adaptation expenditures for “communities” (IPCC’s “human systems”) – which appears to mean human built structures and areas including buildings, built waterways & dams, roads, bridges, telecommunication systems, agriculture infrastructure/areas, etc. Figuring out what to include and exclude in these types of expenditures is the challenge.

(3) Eurostat funded project to delineate climate change mitigation and adaptation activities

(Project ES-TAT/E/2019/009, lot 6)

The portion of this project related to climate change mitigation and adaptation is taking a similar approach to the Eurostat established Environmental Goods and Services Sector (EGSS) statistics where indicative lists of industries and products are provided to help guide countries in evaluating if/how much of certain economic activities and products should be included. Preliminary work has identified between 120 and 282 economic activities related to climate change mitigation, and between 95 and 154 economic activities related to climate change adaptation.

The usual challenges with this type of approach are encountered. The biggest one is although a specific, relevant good or service description is made, it is hard to figure out where in the industry or product lists this item is found.

And then typically it is only a part of a larger category so determining the portion of the category to include is the next challenge. If these lists could be successfully established, they would be very helpful in developing CC mitigation and CC adaptation expenditure statistics. Eurostat is not the only one trying to identify and/or define what are climate change related expenditures. There are a number of attempts at budget tagging.

3.3 Climate Change Budget Tagging – OECD approaches

The OECD Development Assistance Committee (DAC) produces annual statistics on aid and other resource flows to developing countries. As part of this effort the OECD established “budget tagging” as the method for identifying the different flows. There are two methodologies, (1) the Rio Marker methodology and (2) the Climate Components methodology. The Rio Marker methodology is applied to development finance by bilateral providers and the Climate Components methodology is applied to development finance by multilateral development banks.

The OECD states that, “There is no internationally agreed methodology for assessing the exact share of aid activity expenditure that contributes to climate change adaptation or mitigation.” Although we are wanting to identify CC expenditures in the national economy and not only related to foreign aid, it is worth examining the budget tagging definitions.

OECD Definitions and Criteria for Eligibility for Climate Change Mitigation and Adaptation Budget Tags

CLIMATE CHANGE MITIGATION

Definition

An activity should be classified as climate-change mitigation related (score Principal or Significant) if:

It contributes to the objective of stabilisation of greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system by promoting efforts to reduce or limit GHG emissions or to enhance GHG sequestration.

Criteria for Eligibility

The activity contributes to

- a) the mitigation of climate change by limiting anthropogenic emissions of GHGs, including gases regulated by the Montreal Protocol; **or**
- b) the protection and/or enhancement of GHG sinks and reservoirs; **or**
- c) the integration of climate change concerns with the recipient countries’ development objectives through institution building, capacity development, strengthening the regulatory and policy framework, or research; **or**
- d) developing countries’ efforts to meet their obligations under the Convention.

The activity will score “**principal objective**” if it directly and explicitly aims to achieve one or more of the above four criteria.

CLIMATE CHANGE ADAPTATION

Definition

An activity should be classified as adaptation related (score Principal or Significant) if:

It intends to reduce the vulnerability of human or natural systems to the current and expected impacts of climate change, including climate variability, by maintaining or increasing resilience, through increased ability to adapt to, or absorb, climate change stresses, shocks and variability and/or by helping reduce exposure to them.

This encompasses a range of activities from information and knowledge generation, to capacity development, planning and the implementation of climate change adaptation actions.

Criteria for Eligibility

An activity is eligible for the climate change adaptation marker if:

- a) the climate change adaptation objective is explicitly indicated in the activity documentation; **and**
- b) the activity contains specific measures targeting the definition above.

Carrying out an assessment of vulnerability to climate variability and change, either separately or as an integral part of agencies’ standard procedures, facilitates this approach.

(Source: Revised Climate Marker handbook, https://www.oecd.org/dac/environment-development/Revised%20climate%20marker%20handbook_FINAL.pdf)

Although this is called “budget tagging” the unit of analysis is not a national budget or even a Ministerial or U.S. Department level but is at a finer-grained level – most likely at a project level.

The Rio marker system assigns a weighted marker to each project based on the financing rationale connected to climate considerations. The weighting is a 100-40-0 system. If the project is judged to have ‘principal relevance’ it is given a 100 percent weighting, meaning that the entire financing of the project is included as climate change relevant. If a project is financed for other reasons but makes a significant, positive contribution to climate change mitigation or adaptation it is considered to have ‘significant relevance’ and is weighted at 40 percent. If a project has no relevance to climate change, the project is weighted at 0 percent.

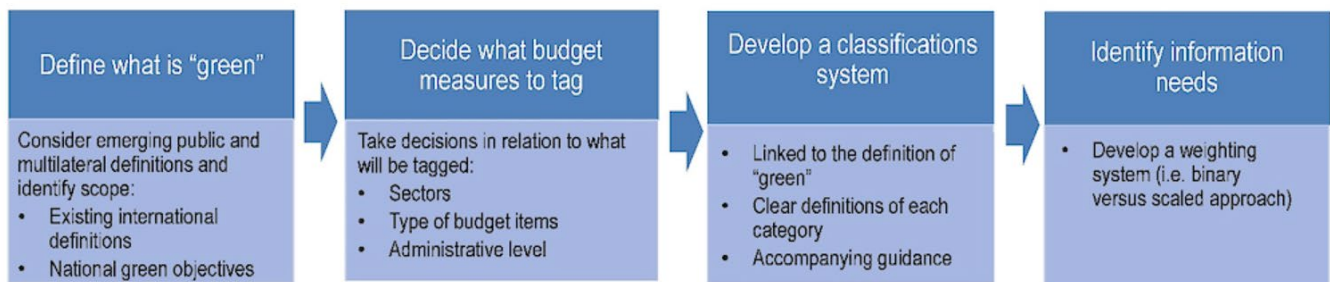
This approach is similar to methodologies used for general budget analyses, where categories are considered fully applicable, not relevant at all, and partially relevant. The fully applicable categories are given a weighting of 100 percent, the not relevant categories are given a weighting of 0, and the partially relevant categories need to be evaluated using other data sources/expert evaluations to develop a weighting. The partial categories require a great deal of time and effort to evaluate and to develop a weighting.

By using a simple 100-40-0 weighting system, the most time consuming and complex step in the project or budget analysis methodology is avoided.

A second OECD effort is called “green budget tagging.” In this case the focus is on the national budgeting process – with advice on how to include environmental objectives in the budgeting process. These are guidelines and not a stipulated single set of practices.

The process is described in the following figure:

Key Decisions in designing an approach to green budget tagging



Source:
 OECD Green Budget Tagging: Introductory Guide and Principles
<https://www.oecd.org/gov/budgeting/green-budget-tagging-fe7bfcc4-en.htm>
 Figure: [Source](#)

This OECD Guide provides good advice on how to implement this type of process but it does not provide definitions of what to include or exclude. Having each country develop its own definitions is not going to lead to comparable results between countries. Admittedly what climate change adaptation activities in one country may not be applicable in another country but what to include and exclude needs to be decided if any of these types of analyses can be used for developing statistics.

3.4 Green budgeting – European Union

The European Union (EU) has also developed guidelines for the EU budget and for member states to use for implementing ‘green budgeting. Here we find a few more definitions that could help identify climate change expenditures. In the EU, “green budgeting” means,

“...using the tools of budgetary policymaking to help achieve climate and environmental goals. Green budgeting is a process whereby the environmental contributions of budgetary items and policies are identified and assessed with respect to specific performance indicators, with the objective of better aligning budgetary policies with environmental goals.”

(Source: https://economy-finance.ec.europa.eu/economic-and-fiscal-governance/green-budgeting-eu_en).

In the OECD case, the reason for financing projects is the evaluation criterion regarding its inclusion as a climate change related project without requiring an understanding of the relevant effects of the project. This could lead to the same type of project being classified differently depending on the financing rationale. Given this type of risk, the European Commission has chosen to use a system of classification by “type of action” and has developed a tracking system using EU climate coefficients (which is the same as OECD’s three-tier 100-40-0 weighting system). The classification of “types of action” means the expected effects on climate rather than the reason for financing.

3.5 European Union Taxonomy for Sustainable Activities

The EU Taxonomy is “a classification system that helps companies and investors identify ‘environmentally sustainable’ economic activities to make sustainable investment decisions.” (<https://ec.europa.eu/sustainable-finance-taxonomy/>). This scheme is relevant for companies and investors – and includes reporting requirements.

In this scheme, a list of qualifying activities will be established and continuously revised. The following figure describes what the EU taxonomy is and is not:

EU Sustainable Finance Taxonomy – what it is and is not

What the EU Taxonomy is	What the EU Taxonomy is not
A classification system to establish clear definitions of what is an environmentally sustainable economic activity	It's not a mandatory list to invest in
Tool to help investors and companies to make informed investment decisions on environmentally sustainable activities for the purpose of determining the degree of sustainability of an investment	It's not a rating of the "greenness" of companies
Reflecting technological and policy developments: The Taxonomy will be updated regularly	It does not make any judgement on the financial performance of an investment
Facilitating transition of polluting sectors	What's not green is not necessarily brown. Activities that are not on the list, are not necessarily polluting activities. The focus is simply on activities that contribute substantially to environmental objectives.
Technology neutral	
Fostering Transparency by disclosures for financial market participants and large companies related to the Taxonomy	

(Source: <https://ec.europa.eu/sustainable-finance-taxonomy/>)

The Taxonomy Regulation has 6 climate and environmental objectives, where climate change mitigation and adaptation are the first two objectives. There are also 4 overarching conditions that an economic activity must meet in order to qualify as environmentally sustainable:

1. Making a substantial contribution to at least one environmental objective;
2. Doing no significant harm (DNSH) to any of the other five environmental objectives;
3. Complying with minimum safeguards; and,
4. Complying with the technical screening criteria set out in the Taxonomy delegated acts.

The Commission delegated regulations specify the economic activities that meet the EU requirements. For example, Annex I of Delegated Regulation (EU) 2021/2139 of 4 June 2021 (<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021R2139>, pages 16-139) provides descriptions of qualifying activities for climate change mitigation. The list includes, for example, Forestry – including afforestation, conservation forestry, and forestry management; Environmental protection and restoration activities – including restoration of wetlands; Manufacturing – includes a wide list of activities; Energy – generation from renewable sources, and storage. The list continues to include transportation, water, wastewater, construction, etc.

Similar to the OECD DAC markers, the unit of analysis is “projects” which includes reporting about these projects by companies to the EU Commission. If this data is collected in an appropriate and systematic manner, it could be a data source for developing statistics on investments by companies related to climate mitigation and adaptation. It will not cover other economic variables – such as current expenditures to maintain the investments or employment. Currently only a list of climate mitigation activities has been published. This means that no list currently exists for climate adaptation activities but future delegated regulations are expected to be issued for the other 5 climate and environmental objectives. In the future, these EU lists of economic activities could be useful in identifying specific economic activities that are related to climate mitigation and climate adaptation.

3.6 Inter-American Development Bank (IADB) – Government spending on climate change

An IDB report, “Climate Change Public Budget Tagging: Connections across Financial and Environmental Classification Systems,” (<http://dx.doi.org/10.18235/0003021>) provides an excellent evaluation regarding the development of a methodology for defining and identifying climate change expenditures and points out where the current approaches of existing statistical classification systems are not adequate. For example, the main purpose criterion does not work in many cases:

Currently, functional classifications use the principal purpose or motivation criteria to identify spending associated with environmental phenomena. The problem with this criterion is that it excludes expenditures for activities that have a significant effect on climate change but that are not explicitly intended to deal with climate change. For example, investment in a renewable energy plant would not be considered a climate change mitigation expenditure if the intent of the project is energy production, not climate mitigation, but it is an investment that mitigates climate change.

(Source: IADB report, <http://dx.doi.org/10.18235/0003021>, page 26)

The proposal is to have both a primary and a secondary tagging system. The primary tag would have climate change as the main purpose and the secondary tag would be either those expenditures that have no climate change intent but have a measurable impact or those expenditures that are actual responses to climate change impacts.

The second IDB report, “A Conceptual Framework for the Classification of Government Spending on Climate Change,” (<http://dx.doi.org/10.18235/0004449>) goes into more depth proposing a conceptual framework and methodological guidelines which allow the identification, classification, and evaluation of public spending related to climate change, in an integrated approach coherent with current statistical systems.

Expenditures that have a main purpose of CC mitigation or adaptation would be identified as ‘primary’ and a secondary tag would be “Climate-Relevant Activities (CRA)” due to their technical nature. CRA are defined as “actions, processes, services or product generation that—depending on the characteristics of the final products, the type of process or the services they generate— either have an impact on climate change or respond to it” (page 22). The following table expands on these CRA activities.

Activities that are Climate-Relevant due to their Technical Nature

CRAs are actions, processes, services or the generation of products that—depending on the characteristics of the final products, the type of process or the services they generate—either have an impact on climate change or respond to it. Such activities can be positive or negative.	
Positive CRAs	Activities with an impact on climate policy that affect the capacity to limit the effects of climate change or its impacts. There are three types of policy responses to climate change: mitigation, adaptation and mixed (IPCC, 2014a; IPCC, 2014b).
Mitigation	Activities that help to stabilize the concentration of greenhouse gases (GHG) in the atmosphere to levels that would avoid a dangerous anthropogenic perturbation of the climate system, by promoting initiatives to reduce, limit or sequester such emissions.
Adaptation	Actions or activities undertaken in the process of adjusting to the real or projected climate and its effects, whose aim is to moderate the damage or exploit any beneficial opportunities. In natural systems, in the process of adjusting to the real climate and its effects, human intervention can facilitate adjustment to the projected climate. In the case of extreme hydrometeorological events, adaptation to climate change corresponds to disaster risk management, insofar as it aims to reduce vulnerability or improve resilience in response to observed or expected changes in the climate and its variability.

Mixed	Activities that mitigate and reduce the vulnerability of human or natural systems to the impacts of climate change and climate-related risks, by conserving or increasing the capacity of adaptation and resilience, even though it is impossible to differentiate between activities undertaken with these aims.
Negative CRAs	Activities that have substantial, observable and potentially measurable impacts on climate change. The base is comprised of the activities identified in the list drafted by the Intergovernmental Panel of Experts on Climate Change (IPCC) (Annex 4). For example, coal-burning power stations. There are two types of Negative CRAs: 1) production, distribution and use of fossil fuels, and 2) processes with a highly negative climate impact (agriculture, etc.).

Source: A Conceptual Framework for the Classification of Government Spending on Climate Change, (<http://dx.doi.org/10.18235/0004449>), Page 23

When developing a new system, it is very helpful to see how the different pieces fit together. The following figure provides a visual image of how these different parts relate to each other and fit together. In this case, climate expenditures and disaster management are shown.

Structure of the Climate Expenditures Classification System¹

		<i>Ex ante</i> expenditures in relation to an extreme weather event			<i>Ex post</i> expenditures in relation to an extreme weather event			
		Expenditures that respond to climate change		Expenditures that increase climate change	Expenditures that respond to the impacts of climate change (defensive expenditures)			
Climate-relevant expenditures, irrespective of impact or purpose	Positive climate-relevant expenditures	Primary purpose climate expenditures	Mitigation	Adaptation	Mixed activities			Recovery and resilient recovery (resilient reconstruction)
				Disaster management and resilience				
	Expenditure in positive climate-relevant activities (secondary purpose)	Mitigation	Adaptation	Mixed activities				
			Disaster management and risks posed by climate phenomena					
Negative climate-relevant expenditures	Expenditures to tackle climate impacts (secondary purpose)					Recovery	Emergency	
	Expenditure in negative climate-relevant activities (optional)				Anti-mitigation (negative mitigation)			

¹ Source: A Conceptual Framework for the Classification of Government Spending on Climate Change, (<http://dx.doi.org/10.18235/0004449>), Table 2.2, page 33. Annexes 2, 3, and 5 in this report develop classifications of climate change expenditures. Annex 2 presents a classification of primary purpose climate change expenditures and a classification of secondary purpose – with descriptions and codes at the 2-, 3- and 4-digit levels.

Classification of primary purpose expenditures (1-digit level):

Code	Description
1.0.0	Mixed
2.0.0	Mitigation
3.0.0	Adaptation and Disaster Risk Management

Classification of secondary purpose recovery and emergency expenditures (1-digit level):

Code	Description
4.0.0	Emergency
5.0.0	Recovery

Annex 3 presents a methodology for identification and classification of climate activities. Key here are the descriptions of the criteria for identifying mitigation activities and adaptation actions. Table A3.4 provides a list of the different types of actions cross-categorized to ISIC and governmental function. These cross references help to identify where to look in the standard government financial accounts to find these types of expenditures.

Annex 5 provides a table which helps to identify various climate expenditures which were previously catalogued according to the Classification of the Functions of Government (COFOG).

With the definitions that define what to look for and the Annexes which tell you where to look, this framework provides a practical approach to try to start developing climate change and disaster expenditure statistics. The problem with these guidelines is the detail at which the analysis is required. The approach advocated is needing to be implemented at a project level.

3.7 Austria – Federal government current costs for climate change adaptation

The focus of the Austrian project (http://anpassung.ccca.at/pacinas/wp-content/uploads/sites/3/2017/07/10_Knittel-et-al-WP4-2017.pdf) was to identify federal government current costs for adaptation to climate change in Austria and used 4 steps.

The first step was to examine the federal government’s budget plan, realization reports, and global and detailed budgets were screened using key terms such as, “environment”, “energy efficiency”, “constructional measures”, “climate change”, “flood”, “preventive measures”, and “adaptation.” In step 2, a number of budget positions were inspected more closely. Step 3 involved interviewing numerous ministerial staff members and developing expert estimates of the climate adaptation portion of the budgetary line items. The final step was to use the experts’ estimates to estimate the actual adaptation costs using the proportion of the total expenditures that were directly relevant.

The Austrian method of using experts to estimate the proportion of budget items provides a more nuanced approach since the amount for partially relevant budget items can vary between 10-90%. The EU methodology for government budget analysis (see section 3.4 above) only uses a 100-40-0% weighting scheme – assigning 40% to all partially relevant categories.

The analysis focused on the following seven activity fields: agriculture, forestry, water resources and water management, protection from natural hazards, disaster risk management, ecosystems and biodiversity and transportation infrastructure. Using this focused approach preliminary estimates for adaptation expenditures and costs were made for 2014.

3.8 Status in developing a classification system for CC mitigation and CC Adaptation

The IDB work is the most developed framework having developed definitions, evaluation criteria, and classifications for the climate related expenditures. The methodology is specifically tailored to government expenditures and uses a budget analysis approach to data collection and statistics.

The EU Taxonomy Regulation provides the most concrete private sector list of climate change mitigation activities. If the reporting to this regulation is established in a smart manner, the data could be a source for European statistics.

The Austrian project produced estimates of federal government level climate change adaptation current costs using a modified EU methodology. Identifying which budget items to include/exclude and the weighting of the partially relevant budget line items were the biggest challenges.

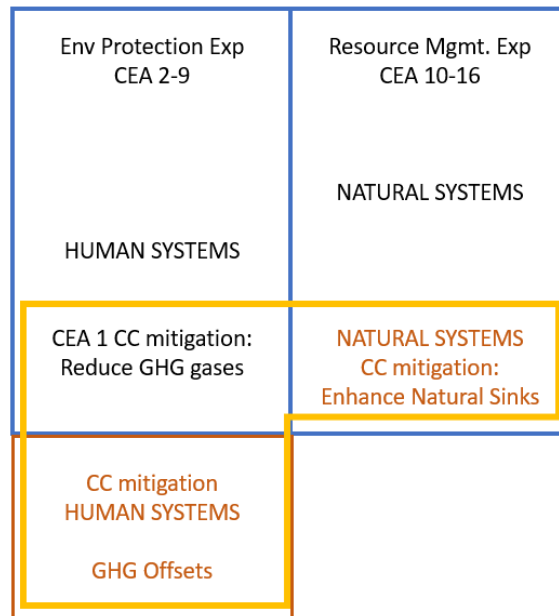
And finally, the Eurostat financed project identifying climate change activities, industries and products is the most integrated attempt at developing statistics using the European supply and use tables to develop satellite accounts for climate change expenditures. The methodology, with the product lists used, has not yet been published. As with all SUT based satellite accounts, defining the relevant portion of the product categories is the most challenging aspect of this methodology.

The methodology work is focusing mostly on government budget analyses – which is not surprising since government finances are the most accessible data sources to analyze. The IDB, EU methodology, and the Austrian project all focused on government budgets. The EU Taxonomy Regulation is for investments in the private sector and contributes with a list of activities that address climate mitigation. And it is the Eurostat project that is attempting to use a SUT approach to develop satellite accounts.

4 Fitting the pieces together: Combining EPE/RM, CC Mitigation, CC Adaptation, and DRR

Given the varied approaches briefly summarized above, one contribution of this paper is that we would like to try to reconcile varied current practices in a simple way. It can be useful to visualize how the different pieces of this classification puzzle fit together. In the following figures, environmental protection expenditures (EPE), resource management (RM) expenditures, Climate Change (CC) mitigation expenditures, climate change adaptation expenditures, disaster preventive and adaptive expenditures, and disaster recovery expenditures will be shown to overlap in various ways. An important aspect which has not been discussed in any of the reports is the dimension of human systems and natural systems which is key to the IPCC definition of climate adaptation.

Figure 4.1 Environmental protection expenditure, Resource Management, and Climate Change mitigation expenditures in human and natural systems



The brown text shows new topics that have not been previously identified in the EPE/RM statistical definitions and methodologies since GHG offsets and enhancing natural sinks are not included in the current system boundaries. The yellow lines encompass all of the mitigation expenditures that are part of the IPCC definition. These types of expansions of what is included in climate change mitigation activities also needs to be considered in the revision of the Classification of Environmental Activities.

The major change that needs to be considered is the dimension of natural systems and human systems that are so clearly part of the IPCC definition of climate change adaptation:

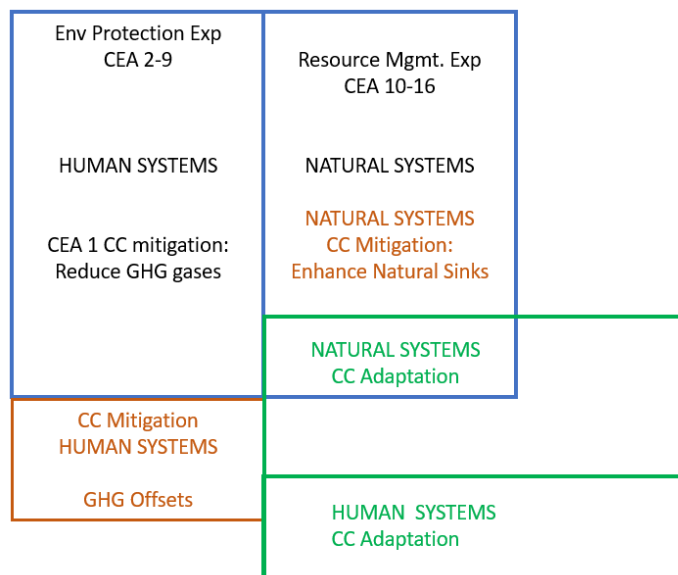
Adaptation

In *human systems*, the process of adjustment to actual or expected *climate* and its effects, in order to moderate harm or exploit beneficial opportunities.

In *natural systems*, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects. (Source: <https://apps.ipcc.ch/glossary/>)

Adding Climate Change Adaptation – in human systems and natural systems – is shown in the following figure with the green lines.

Figure 4.2 Environmental protection expenditure, Resource Management, Climate Change mitigation and Adaptation expenditures in human and natural systems



Some climate change adaptation in natural systems occurs without human actions. Fish stocks in the oceans move to waters with the temperatures that these fish species need – for example, the cod along the northern Norwegian coast has moved to colder waters in more northern latitudes. But some human activities (and their related expenditures) can assist natural systems to adapt. Some examples include:

- In Coastal areas, the planting of mangroves or other wetland species—can reduce the threat of inundation while also providing a habitat for marine life and improving water quality.
- Climate-smart agriculture, which preserves and enhances topsoil.
- Decreasing deforestation.
- Constructing terraces on hillsides, using vegetation at critical points to control soil erosion, increase soil moisture, and reduce runoff.

Some of these ‘nature-based solutions’ would be part of resource management expenditures and ecosystem improvement and resilience.

In human systems, adaptation and resilience are often discussed in terms of building codes and standards. When the August 2023 hurricane, Idalia, made landfall in Florida, it “ravaged the isolated fishing village of Horseshoe Beach, leaving it a community of contrasts: Dozens of modest homes along the Big Bend coast were heavily damaged in the floodwaters, but interspersed among the debris were residences left relatively unscathed, all because they were built elevated on stilts... State officials and home building experts contend it's not so much luck as regularly revised state building codes that allow certain homeowners to dodge total destruction.” (Source:

<https://www.nbcnews.com/news/us-news/hurricane-idalias-destruction-skipped-homes-floridas-coast-rca102887>)

Figuring out which types of expenditures to include as climate change adaptation expenditures in human systems is challenging. As we have seen from the work on CC adaptation expenditures by the OECD, EU and others, the unit of analysis is often a project – which is not the typical unit of analysis used in making national level statistics.

Collecting project level data and developing statistics from these data would be extremely challenging and expensive.

The SEEA-CF research agenda (see section 1. Introduction) also mentions natural hazards in addition to climate change as part of the larger research topic. Disasters are covered under the Sendai framework. The Sendai framework for disaster risk reduction is a key reference point together with the UNESCAP led work on the Disaster-related Statistics Framework (DRSF) (<https://stat-confluence.escap.un.org/display/TWG/DRSF%3A+Disaster-related+Statistics+Framework>).

The Sendai framework has four priorities for action, two of which are particularly relevant for expenditure statistics. The first is, “Investing in disaster risk reduction for resilience”; and the second is, “Enhancing disaster preparedness for effective response and to ‘Build Back Better’ in recovery, rehabilitation and reconstruction.”

The DRSF is more specific and sets up two tables of the Disaster Risk Reduction Expenditure Account (DRRE) to be filled out by countries, the “Production expenditure account (current plus investment) by characteristic activities” table and the “Transfers expenditure account & DRR National Expenditure” table. There are no descriptions or guidelines for filling out these tables beyond the titles of what should be included. (https://stat-confluence.escap.un.org/download/attachments/16155350/DRSF%20Tables_2021_Final.xlsx?version=1&modificationDate=1630638521026&api=v2).

In the field of disasters – there are concepts of reducing risk and the timing of a specific event – before, during, after. The terms are overlapping with those used in the climate change, especially the use of mitigation and adaptation, but the meanings are not necessarily the same since they are only used in respect to before a disaster:

- Before: Preventive / mitigate / adaptive
- During: Response & protection
- After: Recovery

The expenditure categories include disaster risk prevention, mitigation, management and recovery but there is no explanation of what these different categories should include. In addition, there is a variety of confusing terminology: “disaster-related expenditures,” “disaster risk expenditures,” “disaster risk reduction expenditures” “Disaster risk management expenditure.” These terms may or may not mean the same thing.

The U.S. Census Bureau has examined the DRSF and has mostly focused on the population data and other geo-referenced data that could be used in developing disaster-related statistics in the U.S. The Census Bureau did not make any comments regarding the DRRE tables (<https://www.census.gov/content/dam/Census/programs-surveys/international-programs/stic/disaster-statistics.pdf>).

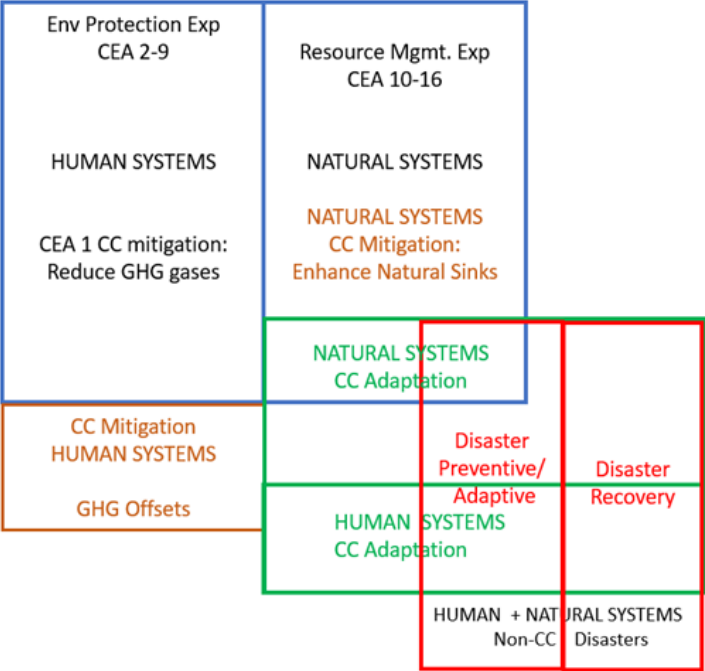
Both the climate change and the disaster framework use the term “resilience” which appears to have a fairly stable meaning across different fields, “The capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure. Resilience is a positive attribute when it maintains capacity for adaptation, learning and/or transformation (Arctic Council, 2016).” (<https://apps.ipcc.ch/glossary/>)

The next logical step is to add disasters into the picture – especially since some of the climate change mitigation and adaptation actions needed are not only focusing on the longer term, slower developing “new normal” but are having to do with specific extreme events. Many of the disasters are related to climate/weather events such as hurricanes and typhoons, tornadoes, drought, wildfires, etc. There are disasters that are not climate related, but which are part of the natural systems such as volcano eruptions, earthquakes, tsunamis. And there are disasters that

start with human systems – such as cyber attacks of critical infrastructure, nuclear power plant melt downs, explosions from natural gas leaks or ammonium nitrate storage, etc.

In figure 4.3 we try to combine these three types of expenditures – EPE/RM / CC / Disaster.

Figure 4.3 Environmental protection expenditure, Resource Management, Climate Change mitigation and Adaptation expenditures, and Disaster preventive/adaptive and recovery expenditures in human and natural systems



The illustrations above depict tangible boundaries as a starting point for classifying these types of activities. We attempt to further illustrate with some examples of the different types of relevant expenditures to determine if the different situations are covered and could be placed into this picture. (See Annex for a list of some recent examples from the USA).

This illustration could be useful when making more precise descriptions and definitions of these various types of expenditures. There is a policy demand for each of these different types of expenditure statistics – and as the figures show, there is a very high chance that there would be double counting if these separate types of statistics are developed and simply added together. Many of the indicators that the larger agreements develop use expenditures per GDP – for example, climate change expenditures per GDP or disaster expenditures per GDP. These definitions are not precise and therefore the indicators can be misleading if not made in a standard way.

5 Next Steps

Recent U.S. work has focused on developing environmental activity accounts, which includes a pilot account quantifying the environmental goods and services sector (EGSS).² This research had leveraged very detailed data from the Bureau of Economic Analysis’s most detailed supply and use tables along with other supplementary data.

² See: <https://www.nber.org/books-and-chapters/measuring-and-accounting-environmental-public-goods-national-accounts-perspective/accounting-environmental-activity-measuring-public-environmental-expenditures-and-environmental>

Our evaluation of the current work on climate change mitigation and adaptation expenditures, coupled with the lessons from recent U.S. efforts, inform our assessment of the most plausible next steps forward. First, one tangible path forward for the U.S. and other data-rich countries that produce detailed supply-use/input-output tables would be to examine the product groups of these tables to identify climate change mitigation and adaptation goods and services. Note that, as we discussed above, climate change adaptation is not simply a subset of the existing SEEA-CF standard, so product groups for this account would also not be a subset of the prior work. Expanding the current approach used for SEEA-based environmental activity accounts would also imply that the SEEA-CF ‘main purpose’ criteria could be a logical approach to carry forward, maintaining consistency in classification of these activities across accounts. Although, as we discussed above, there are still challenges with maintaining the ‘main purpose’ criteria as it applies to climate change mitigation and adaptation expenditures. Departures from this should be considered in tandem with the methodology used for the other environmental activity accounts to promote comparability and consistency if a new/modified classification approach is adopted.

Second, the prior pilot effort for developing a U.S. EGSS account had found that public sector expenditures play a substantial role. Therefore, further examination of government agency budgets would be important, both at national and state/local levels. The lists of activities developed by IDB and the EU Commission will be very helpful to consistently identify relevant economic activities as a starting point.

Finally, the product groups in the internal BEA supply-use data contain more than 5,300 distinct categories, which is among the most detailed in the world. However, as the prior pilot EGSS effort has shown, these do not perfectly align with the definitions for environmental goods and services. This is not unique to environmental accounts. In fact, as with the development of all satellite accounts using a supply and use approach, determining the percent of each category that is partially relevant will be the most challenging part of this work, requiring supplemental data to fill in gaps and estimate proportions of these categories that should be included. We would expect very similar challenges with classifying climate change mitigation and adaptation expenditures. And, when these international classification systems are revised over time, categories relevant for climate change mitigation and adaptation expenditures may be part of a broader discussion for how revisions to these classifications could support environmental-economic accounting. Just as the U.S. pilot EGSS account shed new light on how some of these categories could be revised in the future, a similar exercise for climate change mitigation and adaptation expenditures could provide parallel insights for this particular application.

The next steps for international statistical work would be to continue to develop frameworks, definitions, and selection criteria for the development of environmental protection, resource management, climate adaptation and mitigation, disaster preventive/adaptive and recovery expenditure statistics in coordination rather than separately. If these three areas are developed separately, it is likely that there will be double counting and unclear system boundaries that would complicate efforts of implementation of these accounts by national statistical offices.

6 Annex: Climate adaptation examples from the U.S. media

It is important to examine how “climate adaptation” is being used and understood so we capture the activities that ‘should be’ included and avoid the mistake made when developing the definitions of Environmental Protection Expenditure. The EPE definition did not include energy savings as a climate mitigation relevant expenditure, however, everyone else did consider expenditures for energy savings as an environmental protection measure. There was a mismatch between the statistical definition and the public’s wider understanding. This mistake needs to not be repeated for climate change expenditures.

The following are examples of climate change expenditures in the media – to gain a sense of what is commonly thought of or considered as climate relevant.

A. Coastal areas

- 1) **'Climate change' forces Eskimos to abandon village**
(<https://edition.cnn.com/2009/TECH/science/04/24/climate.change.eskimos/index.html>)

“The U.S. Army Corps of Engineers has estimated that moving Newtok could cost \$130 million. Twenty-six other Alaskan villages are in immediate danger, with an additional 60 considered under threat in the next decade, according to the corps.”

- 2) **Threatened By Rising Seas, Alaska Village Decides To Relocate**
(<https://www.npr.org/sections/thetwo-way/2016/08/18/490519540/threatened-by-rising-seas-an-alaskan-village-decides-to-relocate#:~:text=Rising%20sea%20levels%20have%20eroded%20an%20Inupiat%20Eskimo%20village%20for,protect%20against%20the%20rising%20waters.>)

“Shishmaref will be underwater within the next three decades, and if we do not do anything, we'll be forced to move to another city like Nome or Kotzebue or Fairbanks or Anchorage, and not many people will move to the same place. So that means our unique community of Shishmaref will soon die out because we have our unique dialect of Inupiat Eskimo language, our unique Eskimo dancing, our unique gospel singing translated in Inupiat. All that will soon die out if we do not move as a community.”

- 3) **Alaska, Washington native villages threatened by climate change receive \$75 million to relocate**
(<https://www.foxweather.com/extreme-weather/alaska-washington-native-villages-threatened-by-climate-change-receive-75-million-to-relocate>)

Under the new Voluntary Community-Driven Relocation program announced this week during the 2022 White House Tribal Nations Summit, three tribal communities will each receive \$25 million to begin relocating core infrastructure threatened by sea-level rise, flooding and extreme weather.

In all, the Department of Interior-managed program received \$115 million for 11 tribes impacted by climate change from the Bipartisan Infrastructure Law and Inflation Reduction Act.

The Newtok Village and Native Village of Napakiak, both in Alaska, and the Quinault Indian Nation in Washington, have been selected to receive \$25 million each to begin community-driven relocation. According to the Department of Interior, these three communities will be the proving ground to develop standards for relocation due to climate change.

FEMA has also awarded the three communities \$17.7 million to help efforts to acquire, demolish and build new infrastructure away from the impacts of climate change.

Eight other communities in Alaska, Arizona, California, Louisiana and Maine will receive \$5 million each to fund planning to decide on the relocation of climate change resilience measures.

- 4) **Entire Alaskan Communities are Sinking into the Ocean—And Many Can’t Move Inland** (<https://www.newamerica.org/future-land-housing/blog/entire-alaskan-communities-are-sinking-into-the-oceanand-many-cant-move-inland/>)

What Does “Managed Retreat” Look Like in Practice?

- 5) **Shifting Sands: Carolina’s Outer Banks Face a Precarious Future** (<https://e360.yale.edu/features/outer-banks-climate-change-flooding>)

In the last decade alone, DOT has spent nearly \$80 million dollars to keep hazard-prone NC 12 open for the year-round residents of the lower Outer Banks. That includes rebuilding the S-Curves three different times, but doesn’t include the cost of three new bridges needed to traverse inlets opened by storms or to bypass the rapidly eroding shoreline. Together, the bridges push the cost of maintaining NC 12 to about a half-billion dollars.

Areas of Rodanthe have retreated over 200 feet in the last two decades and are currently losing about 13 feet of beach per year, according to estimates by the National Park Service, which manages the Cape Hatteras National Seashore.

- 6) **How Miami Can Survive Climate Change** (<https://slate.com/technology/2022/05/miami-climate-change-survival.html>)

Absent large-scale adaptation, things will become increasingly catastrophic for Miami. Worst-case projections for 2100 from the research group Climate Central show South Beach completely inundated and generally uninhabitable, while downtown Miami and nearby residential neighborhoods could experience near-constant street and first-floor flooding. Under this scenario, nationally-critical infrastructure, including Miami International Airport’s runways and the Port of Miami’s cargo docks, will disappear. Additional saltwater intrusion in the Biscayne Aquifer, which is already happening, could deprive South Florida of its primary source for drinking water. And tides could eventually encroach Miami from both the Atlantic and the Everglades.

- 7) **In the wake of Hurricane Ian, two Florida communities prove the power of climate adaptation** (https://www.geiconsultants.com/thought_leadership/power-of-climate-adaptation/)

Punta Gorda and Babcock Ranch in Florida

“Strong building codes, floodable streets, native plantings in prolific greenspaces, building outside of the floodplain, undergrounding vulnerable utilities, and providing microgrids and energy independence. We are all threatened by rising seas, stronger storms, more frequent floods, and more deadly droughts, heat, and wildfire. Building climate resilience into our communities saves homes, saves lives, and preserves the infrastructure we need to thrive.”

- 8) **At risk from rising seas, Norfolk, Virginia, plans massive, controversial floodwall** (<https://www.npr.org/2023/09/02/1193726251/at-risk-from-rising-seas-norfolk-virginia-plans-massive-controversial-floodwall>)

“The city is now moving forward with a massive floodwall project to protect itself, in partnership with the U.S. Army Corps of Engineers. The project will include tide gates, levees, pump stations and nature-based features like oyster reefs and vegetation along the shoreline...But the \$2.6 billion project largely won't protect neighborhoods like Sudderth's from the regular flooding they already experience...While Ford and other critics agree that major storms pose a serious threat to the city, they argue it's shortsighted to spend billions of dollars on a project that doesn't address existing flooding – especially because that flooding is expected to worsen as climate change drives more intense rain and higher sea levels.”

9) Why Hurricane Idalia's destruction skipped some homes along Florida's coast (<https://www.nbcnews.com/news/us-news/hurricane-idalias-destruction-skipped-homes-floridas-coast-rcna102887>)

“In Gulf Coast communities like Horseshoe Beach, some residences were mostly unscathed, while others were obliterated. Experts say building codes played a large role...State officials and home building experts contend it's not so much luck as regularly revised state building codes that allow certain homeowners to dodge total destruction.”

B. Wildfires and smoke

1) Canadian wildfires and smoke: <https://www.nytimes.com/interactive/2023/us/smoke-maps-canada-fires.html>

In early June, the level of particulate matter in the air from smoke became so unhealthy that many U.S. cities set records. Some Canadian cities experienced far worse conditions. At points, it was hazardous to breathe everywhere from Minnesota and Indiana to sections of the Mid-Atlantic region and the South, according to [AirNow](#), a U.S. government data source.

[Visibility decreased to startling degrees](#) in many cities, including New York, Toronto, Cincinnati and elsewhere. In some places, smoke from the fires blanketed the sky in an orange haze.

Much of the smoke that plagued the (US) region could be traced back to a large number of fires burning in Quebec. A storm system swirling off the coast of Nova Scotia forced the smoke from these fires south into the United States, and then east — toward some of the most densely populated areas in the country.

C. Temperature increases on land

1) Heat – both indoor and outdoor workers - <https://www.npr.org/2023/07/10/1185766013/farm-workers-extreme-heat-protection-farmers-safety?sc=ipad&f=1001>

NPR - July 10, 2023

Amid extreme heat, there are few federal protections for workers during hot temperatures. The Biden administration wants to change that but the rule making process is long and the heat won't wait.

Some farmers like Kevin Knight say workers at times may not want to take breaks — especially if they are paid piece rate — meaning they are paid depending on much they pick. Any breaks – even those paid at minimum wage — could cut into their bottom line.

"When they're picking cherries, they don't want to take time out because it costs them money," Knight said. "Mandatory tree breaks irritate them."

- 2) **Heat: What Climate Change Has to do With the Looming UPS Union Strike**
Before union contract negotiations collapsed, UPS was prepared to air condition its vehicles, a long-overdue climate adaptation.

Read in TIME: <https://apple.news/AcMIT8LuLTTysLjDeY59HXA>

“Across the U.S., UPS drivers are braving one of the most immediate aspects of climate change longer, more intense heat waves that make working long hours in wheeled ovens not just uncomfortable, but dangerous.”

- 3) **Malaria** - <https://www.nbcnews.com/nightly-news/video/seven-locally-transmitted-malaria-cases-found-in-florida-and-texas-187624005949>

Mosquitoes: Locally transmitted malaria in Florida and Texas. CC is a major factor: Water, increased temperature, and humidity – ideal breeding grounds for mosquitoes