

Accounting for Climate Change and Environmental Activity: Implementation Challenges in the US and How Harmonization of ESG Reporting Could Help Create a New Set of National Economic Accounts

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Abstract

During the 20th century national income accounting had largely focused on measuring traditional economic activity, like consumption or investment as part of Gross Domestic Product (GDP), or disaggregating output by industry or region. More recently, 21st century challenges with climate change have spurred a rapidly expanding interest in complementary environmental-economic accounts that quantify activities in the economy that are undertaken to protect, rehabilitate, or preserve the environment. In this paper, we develop a new, proof-of-concept environmental activity account for the United States based on accounting principles outlined in the SEEA Central Framework. Because reporting of the underlying data is not yet harmonized by federal, state, and local governments nor the private sector, we first investigate the extent to which a government environmental expenditure account can be populated based on existing, publicly reported data. Though preliminary, the resulting tables shed new light on environmental expenditures by government in the U.S., their relevance to climate change statistics, and the potential benefits to a full set of accounts. Second, we document a host of reporting challenges and data gaps for full implementation of additional environmental activity accounts in the U.S., including an illustration of how harmonization of ESG reporting for environmental activity-related expenditures within the private sector could substantially improve these accounts for users (like policymakers, statisticians, and researchers) and better complement our current set of national accounts. Finally, drawing on international experience constructing climate change indicators and related statistics, we explore new ways to define and classify climate change related expenditures in the economy.

Keywords: environmental activity accounts, climate change statistics, ESG reporting, environmental goods and services, environmental protection expenditures, environmental-economic accounting, national economic accounts

JEL Classifications: E01, H23, Q56

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1. Introduction

Data is central to sound decision-making. In the economics realm, national economic accounts organize data to provide objective and timely information about the economy, which have become a mainstay for both policymakers and the private sector to use to guide their decisions for decades. While the United States and many other countries' governments had produced various economic statistics earlier in the 20th century, it was not until the last half of the century when most coalesced around a common set of accounting principles and standards, namely the United Nation's System of National Accounts (SNA).¹ The most well-known of these official estimates, Gross Domestic Product (GDP), provides one measure of a country's economy – the market value of all final goods and services in a country over a given period of time. While aggregate economic statistics are critical for measuring a nation's economic growth and performance over time, national statistical offices (NSOs) that produce these statistics continually adapt to the needs of decision-makers in the public and private sectors. They now produce a complementary suite of accounts, sub-accounts, annexes, and satellite accounts to break down the components of GDP or tabulate the National Income and Product Accounts (NIPA) in useful ways (e.g., by industry or by region/state).

Given the increasing focus on the environment and climate change in the 21st century by both public and private sector decision-makers, national statistical offices around the world have adapted to this new reality by expanding the suite of the national accounts to meet these demands. Thus, the purpose of this study is to explore the extent to which the U.S. can extend this suite of accounts using existing data to encompass environmental activity – that is, transactions in the economy related to the supply and demand of environmental goods and services (including protection expenditures), resource management costs, and policy instruments such as environmental taxes and subsidies. By producing a set of pilot accounts, or preliminary estimates based on existing public and private data sources, we hope to not only show what is feasible but also provide an initial demonstration on how these accounts might be useful for understanding particular aspects of the environment and climate statistics. Second, we provide lessons learned from examining existing data sources and methods as a starting point for understanding the obstacles for implementation in the U.S. specifically, but these lessons likely have broader

¹ See Coyle's (2015) book *GDP: A Brief but Affectionate History* for a more detailed history of GDP measurement, the national economic accounts, and what is (and is not) measured in these accounts.

applications to other countries more generally. Third, we learned that many of these obstacles are accounting-driven, as public sector budgets and private sector accounting disclosures provide non-standardized, non-harmonized information on environmental-related expenditures. Thus, while we discuss some of our specific contributions to the academic literature below, it is worth underscoring at the outset that one broader contribution is that we outline tangible accounting changes that could be made to harmonize ESG reporting in the private sector as well as budget reporting in the public sector. Indeed, this identifies national accounts as an additional stakeholder in the use of ESG data, which, until now, has flown under the radar in the discussion in the literature regarding the benefits of ESG accounting disclosures. Finally, this research provides a crucial first step toward developing new environmental economic accounts in the United States, where none had existed before, contributing to a rapidly growing literature on environmental economic accounting. Understanding the landscape of the data and the accompanying accounting challenges is a necessary prerequisite for producing timely, high quality accounts measuring economic activities that are undertaken to protect, rehabilitate, or preserve the environment.

As part of a broader trend of countries collecting and disseminating more information related to the environment, the UN Statistical Commission has adopted two manuals as new statistical standards in the last decade: the System of Environmental-Economic Accounting (SEEA) Central Framework (2012 – SEEA CF) and Ecosystem Accounting (2021 – SEEA EA).² These serve to complement the SNA and extend the scope of the national accounts by measuring the assets and services flowing from the environment. Specifically, these satellite accounts complement the SNA by using a common accounting and valuation framework, as they measure physical flows and monetary values of environmental economic activities, assets, and ecosystem services, including land, water, fisheries, timber, mineral resources, and other types of natural resources. According to the UN Statistical Division as of 2020,³ 90 countries now produce at least one account using the accounting approaches prescribed by the SEEA CF or SEEA EA. Many of these countries use these accounts to support public and private decision-making at national and

² Only a portion of the latter manual, SEEA EA, was approved by the UNSC as a statistical standard, designating the chapters on valuation of ecosystem services as still experimental and in need of further development. When it was up for approval, experts from numerous national statistical offices voiced objections to the valuation methods in the manual (e.g., see Brown et al 2021), agreeing with the UNSC, as the SEEA EA chapters included valuation methods seen as incompatible with the SNA framework, among other criticisms.

³ For more information, see: https://seea.un.org/content/frequently-asked-questions#_How_many_countries

local levels (Boyd 2018), as well as support international reporting on global conventions and agreements like the UN Framework Convention on Climate Change, Convention to Combat Desertification, and Sustainable Development Goals (SDGs). The UN and, more recently, non-governmental institutions like the International Monetary Fund (IMF) also collate information from these accounts for a variety of purposes, like global climate change indicators, to track international progress on the environment and related activities for the purposes of policy analysis.⁴

One country that is notably absent from reporting on environmental economic accounts is the United States. While the U.S. government reports a vast amount of information on the environment and the economy, it does not yet construct SEEA-based environmental economic accounts,⁵ as earlier work on these types of accounts was halted in the 1990s.⁶ As a result, international databases like the IMF's Climate Change Indicators Dashboard, for example, are missing data for the U.S. for some of its indicators. For instance, the U.S. reports no data for the indicator on Government Expenditure on Environmental Protection, which generally draws on data from countries that follow a Classification of Functions of Government (COFOG) framework that countries also use to construct SEEA-based environmental expenditure accounts for government expenditures. In this paper, we take an initial step towards filling this gap by constructing a limited, proof-of-concept account for Government Expenditure on Environmental Protection based on available data. We highlight this example because of both its relevance to climate change statistics and that, in theory, "low hanging fruit" as one of the most straightforward of these accounts to construct, being based solely on data from the public sector. However, in practice, because the U.S. government does not follow the COFOG framework, we find that the current state of government accounting in the U.S. is not harmonized in a way that makes it easy to construct a more complete account for this purpose. So, one benefit of taking this initial step is

⁴ See, for example, the IMF's Climate Change Indicators Dashboard which came online in April 2021: <https://climatedata.imf.org/>

⁵ The US Bureau of Economic Analysis (BEA) does, however, produce thematic satellite accounts for Outdoor Recreation and the Marine Economy. They both provide timely and useful statistics for specific aspects of the economy, but this industry-specific approach accounts for only part of the role that environmental activity plays in the U.S. economy and is narrower in scope than the suite of SEEA-based accounts. For more information on these accounts, see: <https://www.bea.gov/data/special-topics>

⁶ For a summary of this effort by the BEA and recommendations for the future of environmental economic accounts in the US, see: National Research Council. 1999. *Nature's Numbers: Expanding the National Economic Accounts to Include the Environment*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/6374>.

that by constructing a pilot account we can catalog and discuss some of the key impediments present in public sector accounting for these purposes.

We also document similar instances with private sector accounting and data sources used for environmental protection expenditures (EPE) and the environmental goods and services sector (EGSS). As we discuss in more detail in the next section, many countries that produce environmental activity accounts rely on extensive questionnaires that are sent to private firms for collection and serve as NSOs' primary data. While the US EPA and Census used to regularly survey firms on related activities decades ago (and as late as 2005⁷), the recent trend for statistical agencies in the U.S. has been to find ways to shed their reliance on costly surveys that firms and individuals find increasingly burdensome. Agencies like the BEA and Census have progressively found ways to incorporate "Big Data" and administrative data as supplements to, or in some cases replacements for, traditional survey data.⁸ Hence, if the U.S. would start constructing these accounts now, then it makes sense to employ a 21st century approach by beginning with data sources that already exist (i.e., "nontraditional data" that is collected for some other purpose, but that may be of sufficient quality to be used for statistical purposes) and, to the extent that gaps remain, subsequently deploying more limited (less burdensome) surveys that fill those gaps.

By examining what public companies disclose in their annual reports and supplemental/voluntary environmental, social, and governance (ESG) disclosures, our investigation of this data also reveals a new reason why firms might coalesce around more standardized reporting for ESG information in terms of environmental economic accounts.⁹ According to a recent report by KPMG, 96 (80) percent of the largest (large and mid-cap) firms around the world already publicly report on sustainability (KPMG, December 2020).¹⁰ As we

⁷ <https://www.epa.gov/environmental-economics/pollution-abatement-costs-and-expenditures-2005-survey>

⁸ For a summary of some of these Big Data efforts by the BEA, see: Moyer, B.C. and Dunn, A., 2020. Measuring the Gross Domestic Product (GDP): The Ultimate Data Science Project. *Harvard Data Science Review*, 2(1). <https://doi.org/10.1162/99608f92.414caadb>. For a summary of uses of nontraditional data sources across the U.S. government and academia for economic measurement, see: Abraham et al. (2019), Editor's Introduction, *Big Data for 21st Century Economic Statistics: The Future Is Now*. National Bureau of Economic Research.

⁹ We should note at the outset that there are different conventions in the literature that define "ESG" activities and the reporting of those activities. We follow Christensen, Hail, and Leuz (2021, p. 1,179), and use the terms "ESG," "CSR," and "sustainability" interchangeably while recognizing that there are subtle differences in these terms. In particular, we define ESG activities are those that "assess, manage, and govern" a firm's impacts on society and the environment. Further, we define reporting as "measurement, disclosure, and communication" about these activities.

¹⁰ The large firms sample (labeled "G250") is based on the world's 250 largest companies by revenue as defined in the Fortune 500 ranking of 2019. The large and mid-cap firm sample (labeled "N100") is based on a worldwide sample

explore later in the paper, there is rich data being reported with these disclosures; but, because these disclosures are largely voluntary, the information is not harmonized around a common set of definitions and classifications, which limits its usefulness. Further, as the international discussion has shifted from the environment more generally to climate change more specifically, we also offer a discussion of climate change statistical classifications and provide ways in which firms and governments might report their data in a way that would better fit climate change statistics in particular.

While there are movements toward greater harmonization of this type of information in the private sector, we propose that firms consider a standard consistent with the definitions and classifications of the SEEA CF and SNA that allow governments to use this information more readily for national accounts. From a self-interest perspective, in addition to the standard benefits to shareholders and other stakeholders that might accrue from the standardization of ESG accounting, we argue that if firms report environmental information in a way consistent with the SEEA CF and SNA, the long questionnaires like those administered in Europe or Canada could be substantially shorter (or perhaps even eliminated), thereby potentially reducing costs by having a single set of books for these expenditures and revenues. From a public goods perspective, if firms are providing this kind of information to the public voluntarily anyway, and the U.S. Securities and Exchange Commission (SEC) is also considering requirements for reporting,¹¹ it may make sense to provide it in a way that would be useful to policymakers and other decision-makers who use national accounts information.¹² As we have found with economic data over the 20th century, this information is most useful to the public when it can be aggregated into digestible national (and regional) statistics like GDP or the unemployment rate, for example, as these provide a more cohesive, overall snapshot of the economy than any single datapoint disclosed by a firm.

This paper makes several contributions to the literature. First, by making an initial push forward in the research and development of new environmental accounts for the U.S., we add to a recent literature that constructs pilot accounts to similarly assess the feasibility of using existing data sources and novel methodological approaches to build proof-of-concept accounts in land,

of 5,200 companies that represent the top 100 companies by revenue in each of the 52 countries and jurisdictions captured in the study.

¹¹For example, see <https://www.sec.gov/sec-response-climate-and-esg-risks-and-opportunities>

¹² See also Vardon et al (2016) and Keith et al (2017) for additional discussion of the use of environmental economic accounts information for policymakers and natural resource management.

water, and ecosystem services (e.g., Bagstad et al 2021, Bagstad et al 2020, Warnell et al 2020, Wentland et al 2020, and Heris et al 2021). Given that it is the largest economy in the world, if the U.S. were to develop a formal set of environment economic accounts, it would symbolize a major step forward for these accounts internationally, and it could meaningfully advance the coverage of international databases on climate change statistics like the IMF's. Second, this paper identifies specific changes that could be made to accounting in the public and private sectors that would enhance the meaningfulness and policy relevance of environmental information currently being disclosed, thus clearing a path for environmental activity accounts in the future. As a result, this work contributes to recent discussion in the academic accounting literature and regulators like the Securities and Exchange Commission (SEC) on the need for standardization of ESG reporting.¹³ While much of the focus of this discussion has been on the usefulness of this information to the firm, shareholders, and other stakeholders at the firm level, our analysis in this paper underscores the relevance of this information at a macro-level. To the extent that environmental and climate change policy is coordinated at national and international levels, having objective macro statistics available is essential for decision-makers to assess policy impacts and tradeoffs much like they do with economic statistics in the National Income and Product Accounts like GDP.

2. What Do Other Countries Do? A Brief International Overview of Environmental-Economic Accounts and Climate Change Statistics

2.A. The System of National Accounts (SNA), System of Environmental-Economic Accounts Central Framework (SEEA-CF), and Environmental Activity Accounts: Some Background

The most recent revision of the SNA – the international statistical standard that governs the national economic accounting methodology – provides guidance for extensions or satellite accounts that move away from a focus about *what* is purchased to *why* or *for what purpose* do these outlays occur. Specifically, in chapter 29 of the 2008 System of National Accounts (SNA2008), it presents extensions to the system of national accounts that support the development of satellite accounts like, for example, tourism, health, and the environment. Regarding the latter, an environmental satellite account identifies the various monetary transactions in the SNA that are

¹³ For a more comprehensive review of the ESG literature in accounting, see for example Berthelot, Cormier, and Magnan (2003), Huang and Watson (2015), and Christensen et al. (2021).

directly related to the environment. Specifically, the SNA defines the scope of this account as measuring the following: “environmental taxes, property income and property rights, and environmental protection, natural resource use and management expenditures” (SNA2008, §29.110). As we noted in the introduction above, international interest in environmental satellite accounts had led to its own manual in 2012, the System of Environmental-Economic Accounts 2012 – Central Framework (SEEA-CF), which extended and applied the methodology from the SNA to establish three main types of accounts: physical flow accounts, monetary flow accounts, and asset accounts (both physical and monetary). The fourth chapter of the SEEA-CF serves as the methodological foundation of environmental activity accounts, which includes guidance on how to produce satellite accounts for environmental protection expenditures, environmental goods and services sector (EGSS), and tax and subsidy accounts.¹⁴

2.B. What is Environmental Activity? Some Conceptual Challenges

Before looking directly at the environmental classifications and what other countries do in a practical sense, it is important to highlight from the SEEA-CF what we are trying to describe conceptually. The SEEA-CF provides the following guidance for deciding whether a transaction’s scope is categorically environmental or not. It is based on the concept of main or primary purpose. The SEEA-CF explains this concept as follows:

“4.11 The scope of environmental activities encompasses those economic activities whose primary purpose is to reduce or eliminate pressures on the environment or to make more efficient use of natural resources.

4.12 These various activities are grouped into two broad types of environmental activity: environmental protection and resource management. Environmental protection activities are those activities whose primary purpose is the prevention, reduction and elimination of pollution and other forms of degradation of the environment...

4.13 Resource management activities are those activities whose primary purpose is preserving and maintaining the stock of natural resources and hence safeguarding against depletion.”

(SEEA-CF 2012, §4.11-4.13)

¹⁴ Prior to the SEEA-CF, however, countries had classified economic activity as environmental in their national accounts. Initially, the Classification of Environmental Protection Activities (CEPA) was established in the late 1980s to serve this purpose, with a focus on pollution and environmental protection. By the time the SEEA-CF was established in 2012, there was also a focus on natural resource management which led to the development of the Classification of Environmental Activities (CEA). The CEA has two parts: Part I Focuses on environmental protection, and Part II on resource management. Now, in 2021, there is an additional focus on resource efficiency.

Determining the primary purpose needs to follow general principles of classification, i.e., that it is consistent with the definitions of the two types of environmental activity – environmental protection and resource management.

In practice, a Department/Ministry of Transportation might claim that all expenditures on railroads were “environmental expenditures,” for example. Their argument might be that the trains reduced the use of road and air transportation, and thus the air emissions from these modes of transportation; therefore, all expenditures for the railroads should be classified as environmental protection expenditures (EPE). Based on the application of the ‘primary purpose’ principle, a national statistical office would likely evaluate this and conclude that, although this may have been one of the results of the expenditures on the railroads, the primary purpose of the expenditures for railroads was rail transport and not primarily for environmental protection. Therefore, the total expenditures on railroads would not be included in the environmental protection expenditure statistics of the government sector as developed by the national statistical office. It is worth noting, however, that expenditures of the Department/Ministry of Transport that did have a primary purpose of environmental protection, such as the construction of noise barriers along railway lines and roads, would be included as EPE.

The example above highlights an important challenge for the U.S. and other countries implementing environmental activity accounts using existing, repurposed statistics: the context through which one set of statistics or estimates was initially developed may not have been constructed initially to be consistent with the guidance regarding the ‘primary purpose’ principle or other principles set forth in the SNA and SEEA-CF. Therefore, it requires expertise in national accounting to sort through the initial purpose and accounting guidelines of, for example, federal budget estimates to determine whether these definitions are sufficiently close to the scope of the corresponding expenditure for a formal environmental activity account line item. In the example, if the federal budgeting policymakers include all train expenditures in their definition of environmental protection expenditures, it is necessary that this type of difference is flagged so that a roadmap for constructing the formal accounts would include recommendations for separating out these kinds of expenditures in the underlying source data to be more consistent with SNA and SEEA-CF guidelines and principles.

2.C. *Environmental Activity Accounts – Some Examples from Abroad*

While the U.S. has not yet implemented these accounts, Eurostat and the members of the European Statistical System have years of experience in collecting data and developing statistics related to environmental activity. The work on a resource management classification was pioneered by Istat, the Italian national statistical office, using their government budget analysis techniques.¹⁵ Based on the Istat work, Eurostat has then developed several iterations of a Classification for Resource Management Activities (CReMA) which were used to inform the SEEA-CF's CEA. Eurostat, however, did not use the SEEA-CF's CEA to inform its further development of the CReMA nor is it being used in the new Eurostat proposals for the revision of the SEEA-CF's CEA, Eurostat made a number of early changes to the CEA which it has used in the EU regulations for data reporting.

For many years the OECD and Eurostat collected Environmental Protection Expenditures and Revenues, but in recent years this data collection has developed into the more wide-ranging, integrative dataset known as Environmental Protection Expenditure Accounts (EPEA). To develop the EPEA, several different datasets must be combined. The three main sets of data cover the government sector using COFOG statistics, environmental protection expenditures (EPE) by industries, and environmental goods and services sector (EGSS). The government COFOG statistics are typically developed by budget and financial account analyses of the different levels of government, while the other two statistics are typically developed using survey methodologies (either annual or periodic with estimations made in non-survey years). For example, Germany (Destatis) has an annual survey for EGSS where the survey provides a list of products and services, and they request a breakout of the total production of the different relevant products and services as well as the split between exports and sales nationally. Destatis also conducts surveys for environmental protection current expenditures and investments.

Statistics Canada has taken a different approach focusing on an Environmental and Clean Technology Products Economic Account (ECTPEA) rather than environmental protection. The compilation of the ECTPEA draws on a variety of data sources, including Statistics Canada's

¹⁵ Ardi, Carolina and Federico Falcitelli (2007) The Classification of Resource Use and Management Activities and expenditure – CRUMA: Developed by Istat consistently with CEPA2000 for the Resource Use and Management Expenditure Accounts of SERIEE. <https://unstats.un.org/unsd/envaccounting/LondonGroup/meeting12/CRUMA.pdf>

supply and use tables, detailed import and export statistics released in Canada's balance of international payments, and the annual Survey of Environmental Goods and Services (SEGS).¹⁶

As experience in Europe has shown, the challenges in implementation primarily arise with the application of a classification for various activities, providing new insights into how a classification could be improved. For this reason, a key contribution of this paper is to identify practical, conceptual, and methodological challenges by reviewing the various categories/classifications used in connection with the different levels of government, statistical entities, and budgeting authorities in the United States in order to identify the potential for developing environmental activity accounts for the U.S. government (including Federal, State, and local level government).

While the UN Statistical Division does not currently have a central SEEA-CF database for country-level data, the IMF Climate Change Dashboard represents a potential new trend in making environmental data more accessible to users. The Dashboard presents a suite of climate change related indicators – some of which use environmental-economic data. These include the trade of environmental goods in imports and exports resulting in an evaluation of a country's comparative advantage, fossil fuel subsidies, environmental taxes, and government expenditure on environmental protection. Data for the U.S. is conspicuously missing in this Dashboard for government expenditures, for example, which is one motivation for this current work. U.S. data for government expenditures and environmental protection expenditure accounts are also absent from the OECD database,¹⁷ however environmental tax revenues are available (but not by NACE categories – known as environmental tax accounts). In some cases, when the countries themselves do not provide environmental data, international organizations will impute or model data to fill some of these gaps, or they will find data that could be reported elsewhere outside of formal accounts. One additional motivation for the U.S. and other countries to provide high quality data themselves is to avoid the data being filled in with modeled data, which may or may not accurately reflect the true numbers.

¹⁶ <https://www150.statcan.gc.ca/n1/daily-quotidien/210413/dq210413e-eng.htm>

¹⁷ <https://doi.org/10.1787/env-data-en>

3. Government Expenditures on Environmental Protection and Public Sector Accounting Issues

Compared to countries with more unified statistical systems, classification of government expenditures related to environmental activities presents a unique challenge in the United States. The U.S. has a decentralized federal statistical system, composed of twelve “principal statistical agencies” that provide official government statistics, as well as numerous other units that provide supporting data, statistical analysis, or policy guidance (e.g., Congressional Budget Office or the Office of Management and Budget).¹⁸ These agencies, which produce the underlying data/statistics used for classifying environmental economic activity in the U.S., have developed somewhat different classification norms that are specific to the statistical products they currently provide to the public, making any effort to assemble an account for another purpose inherently more complex. Hence, to provide context for how one would go about constructing this kind of account in the U.S., we first describe and compare the current government expenditure classification systems used by the different American statistical agencies (UN, BEA, Census) and the budgeting authorities (Congress, White House). We then describe where expenditures related to environmental protection expenditure and resource management expenditures are located among these systems. Finally, we discuss the detailed data collection systems for the state and local governments, which serve a critical role for collecting much of the underlying data relevant for these accounts. These classification systems and data collection systems are essential starting points for understanding the nature of a decentralized statistical system in the U.S. and critical for further development of expenditures related to the environment, which is one of the contributions of this paper.

3.A Accounting Challenges in the Public Sector: Environmental classifications used in the United States Government

¹⁸ The Federal Committee on Statistical Methodology lists the following as “principal statistical agencies”: Bureau of Economic Analysis (Commerce Department), Bureau of Justice Statistics (Justice Department), Bureau of Labor Statistics (Labor Department), Bureau of Transportation Statistics (Transportation Department), Economic Research Service (Agriculture Department), National Agricultural Statistics Service (Agriculture Department) National Center for Education Statistics (Education Department), National Center for Health Statistics (Health and Human Services Department), National Center for Science and Engineering Statistics (National Science Foundation) Office of Research, Evaluation, and Statistics (Social Security Administration), Statistics of Income (Treasury Department), U.S. Census Bureau (Commerce Department), and the U.S. Energy Information Administration (Energy Department). Source: <https://nces.ed.gov/FCSM/agencies.asp>

A major challenge to constructing these accounts is the decentralized nature of the national statistical system in the U.S.. In this section, we now discuss the classification systems used in the different agencies and how this would influence data collection and statistical products related to environmental activity expenditures. Table 1 uses the UN Statistical Divisions' Classification of Functions of Government (COFOG) which were designed to be broad enough to be used by virtually all governments around the world as the starting point to organize the various U.S. classifications. When starting from the COFOG, one can quickly see that none of the U.S. statistical classification systems for government expenditures of the BEA, the OMB, or the Census Bureau have a separate category that corresponds to COFOG 05 Environmental Protection.

For the Bureau of Economic Analysis (BEA) and the National Income and Product Accounts (NIPA) it produces, the environmental expenditures are largely contained in the housing and community services (06) and the economic affairs functions (04). In the Office of Management and Budget's classification system, the 'natural resources and environment' function can be found in the aggregated category, which is dominated by agriculture. The OMB agriculture category also includes several other functions including Energy, this large category maps to COFOG (04) Economic Affairs, and relevant expenditures in the 'community and regional development' function are found in COFOG 06 Housing and community amenities. In the Census system, the environment is primarily contained in the 'environment and housing' function (06).

The challenge for us here is that these statistical presentations do not separate out the environment to any easily adaptable way conducive for aggregate environmental activity accounts, which might explain why this project has not yet been undertaken in the U.S.. It turns out that, if we look in more detail under these numbers, we can mine some useful data for the purposes of assembling a preliminary, pilot set of estimates for an environmental activity account. Thus, we now turn to the input data used for these systems and the budget agencies' classification systems. The Congressional and White House budgeting categories along with the other detailed data collection by Census for the state and local government expenditures provide the closest, most relevant classifications. Specifically, in Table 1, the House of Representatives and White House budgeting categories are shown in the final column on the right. The budgeting category system has a Section 300 'Natural resource and environment' and Section 270 'Energy,' which both include relevant aspects of environmental protection as well as some natural resource management functions. A closer look at these budgeting categories is useful and is included after Table 1.

Table 1. U.S. Classifications used with respect to government expenditures

COFOG	NIPA (BEA)	OMB	Census Bureau	House (Congressional) Budget* and White House Budget Tables**
01 General Public Services	General Public Services	General Government plus International Affairs plus net interest plus allowances	Government Administration Plus interest on general debt Plus general expenditures not elsewhere classified	800 General Government 150 International Affairs 900 Net interest 920 Allowances
02 Defense	National Defense	National Defense	National Defense and international relations	050 National Defense
03 Public order and safety	Public order and safety	Administration of Justice	Public safety	750 Administration of Justice
04 Economic Affairs	Economic Affairs	Agriculture plus Energy plus Natural Resources and Environment plus Transportation plus Commerce and housing credit plus General science, space and technology	Transportation plus Utility expenditure plus Liquor store expenditure	350 Agriculture 270 Energy (partial) 300 Natural Resources and Environment (partial) 400 Transport 370 Commerce and housing credit 250 General Science, Space, and Technology
05 Environmental Protection	(1)	(2)	(3)	270 Energy (partial) 300 Natural Resources & Environment (partial)
06 Housing and Community amenities	Housing and Community services	Community and regional development	Environment and housing	450 Community and regional development
07 Health	Health	Health plus Medicare plus Veterans benefits and services	(4)	550 Health 570 Medicare 700 Veterans benefits and services
08 Recreation, culture and religion	Recreation and culture	(5)	(3)	(6)
09 Education	Education	Education, training, employment, and social services	Education services	500 Education, training, employment, and social services
10 Social protection	Income security	Income security plus social security plus Undistributed offsetting receipts	Social services and income maintenance plus Insurance trust expenditure	600 Income security 650 Social Security 950 Undistributed offsetting receipts

1. Contained largely in the housing and community services and economic affairs function.
2. Contained largely in the natural resources and environment function and community and regional development function.
3. Contained largely in the environment and housing function.
4. Contained largely in the social services and maintenance function.
5. Contained largely in the natural resources and environment function.
6. Recreation is included in 300 Natural resources and environment; Culture is included in 500 Education, training, employment, and social services.

Source for columns 1-4: "Government Spending by Function, A New Presentation" by Karl Galbraith in Survey of Current Business, June 2000, page 20.

(<https://apps.bea.gov/scb/pdf/national/niparel/2000/0600gf.pdf>); *Source : <https://budget.house.gov/publications/focus-function-introduction> ; **Source: see for example: https://www.whitehouse.gov/wp-content/uploads/2021/05/hist05z1_fy22.xlsx

The focus at this stage is at the federal government level.¹⁹ There are 20 Federal level budget functions with varying numbers of subfunctions (for additional detail on these, see: <https://budget.house.gov/budgets/budget-functions>). These functions and subfunction categories have 3-digit codes. The codes can be found in the various budgetary tables which helps to correctly identify the budget line categories. Tables 24-1 and 25-1 for fiscal year 2021 were used for this quick budget category and line item review (see Table 24-1 and Table 25-1). An additional complication for comparison here is that typically budget numbers are reported on a fiscal year, while Census and BEA report calendar year figures.

Table 2a below shows the budgeting categories that are environmentally relevant in greater detail. Starting with function 300 “Natural resources and environment,” we find the following details from the budget description and the items included in the actual budget tables. In the right-hand column we map a tentative classification of some of the relevant categories – mapping to the CEA, COFOG, and CReMA. The next most relevant budget function to consider is 270 Energy. This function includes civilian energy and environmental programs in the Department of Energy. Here we find expenditures related to nuclear waste, energy conservation and efficiency, renewable energy, and various R&D areas that are relevant. There are also expenditures that are not considered relevant or primary in scope for environmental protection or resource management, so these would need to be separated out when developing statistics for a formal environmental activity account consistent with SEEA-CF principles.

There are also a few other potentially environmentally related items in other functions that were identified based on the name of the function or agency’s scope, which include: 453 Disaster relief and national flood insurance fund, 051 Department of Defense—Military: The Department of Defense Environmental Restoration Accounts, 053 Atomic energy defense activities: Defense Environmental Cleanup, 551 Health care services: Agency for Toxic Substances and Disease Registry, Toxic Substances and Environmental Public Health, 252 Space flight, research, and supporting activities: NASA - Construction and Environmental Compliance and Restoration. In some cases, the category also includes other activities, so only a portion of the line item is relevant for the inclusion as environmental expenditures. This is an example where finer data that itemized

¹⁹ Please note that a detailed federal budget analysis was not performed, only an investigation of the categories in the budgets – i.e., codes and descriptions. Department and Agency budgets were also not investigated in detail – only the Federal level budgets were investigated.

these activities into greater detail would be necessary, or perhaps a distribution key would need to be developed based on detailed information regarding these potential activities included in the same categories if these were to be used in a formal account.

Although the statistical products in the U.S. do not have environmental protection or natural resource management categories that allows for the easy separation and identification of the Federal government's expenditures, the federal budget, which is a main data source for the statistics, does have these functions separated in a more useful manner for developing environmental activity accounts. Based on our investigation of the classification systems identified above, we recommend that the budget categories for '300 natural resources and environment' and for '270 Energy' are analyzed at the most detailed level to work towards classifying the expenditures according to environmental domain using the CEA which includes both environmental protection expenditure and natural resource management. Developing distribution keys for categories that include non-environmentally relevant expenditures would be a necessary starting point, which would be the major challenge for completing a comprehensive set of environmental activity accounts in the US.

In the long run, to facilitate both international comparisons and aid in the construction of formal environmental activity accounts, it may also be a consideration that the NIPA be revised to allow for the separation of these environmentally related expenditures at the federal, state, and local levels into a single major category that would correspond more closely to COFOG 05. But, this would also include the resource management aspect which is in the CEA but not captured fully in COFOG 05. Reconstructing these to better align with COFOG 05 could be helpful to policymakers and other users of these statistics, given the extent to which Federal and state governments have major responsibilities in managing natural resources – metallic and non-metallic minerals, energy resources, land, forests, water bodies, wild flora and fauna, fish and fishing activities, etc. To this end, it would also be useful for the state and local level expenditures for water, sewerage, and sanitation/waste to be re-located and included in a broadened environmental category.

Table 2a. House of Representatives and White House Budget Categories with environmental relevance

<p>300 Natural Resources and Environment Function 300 includes programs concerned with environmental protection and enhancement; recreation and wildlife areas; and the development and management of the nation's land, water, and mineral resources. It includes programs within the following federal departments and agencies: Agriculture, Commerce, Interior, Transportation, the Army Corps of Engineers, and the Environmental Protection Agency (EPA).</p>		<p>CEA / CReMA / COFOG categories</p>
301	<p>Water resources Corps of Engineers – Civil works Bureau of Reclamation Watershed, flood prevention, and other Water infrastructure finance</p>	<p>All would be part of CEA 14 Water Resources / CReMA Water</p>
302	<p>Conservation and land management Forest Service Management of public lands (BLM) Farm security & rural investment Fish and Wildlife Service Conservation operators Other conservation and land management programs</p>	<p>Many different: CEA 11 Timber/CReMA 11 CEA 6 Protection of biodiversity and landscapes Not considered environmental CEA 13/CReMA 12 Wild flora & fauna</p>
303	<p>Recreational resources Operation of recreational resources Other recreational resources activities</p>	<p>Not clear if this category is environmental or not</p>
304	<p>Pollution control and abatement Regulatory, enforcement, and research programs State and tribal assistance grants Hazardous substance superfund Superfund resources and other mandatory Other control and abatement activities: Environmental Compliance and Restoration – Department of Homeland Security Offshore Safety and Environmental Enforcement Bureau of Safety and Environmental Enforcement Environmental Protection Agency</p>	<p>COFOG 05 CEA 5 -- All of these protection expenses would need to be split by domain (air, land, water, etc.) and included in the appropriate CEA group</p>
306	<p>Other natural resources National Oceanic and Atmospheric Administration United States Geological Survey Department-wide programs, Interior Other</p>	<p>CEA 12 Aquatic/CEA 1 air and climate CEA 10 Minerals and energy Unclear</p>
<p>270 Energy Function 270 contains civilian energy and environmental programs in the Department of Energy (DOE). This function also includes the Rural Utilities Service of the Department of Agriculture, the Tennessee Valley Authority, the Federal Energy Regulatory Commission, and the Nuclear Regulatory Commission. This function does not include DOE's national security activities, which are in Function 050 (National Defense), or its basic research and science activities, which are in Function 250 (General Science, Space and Technology).</p>		<p>CEA / CReMA / COFOG categories</p>
271	<p>Energy supply Fossil energy R&D Navel petroleum reserves operations Uranium enrichment decontamination Nuclear waste program Federal power marketing Electricity delivery and energy reliability Energy Efficiency and renewable energy Nuclear energy R&D Non-defense environmental management, cleanup, and other</p>	<p>CEA/CReMA 15 Not environmental CEA/CReMA 7 CEA/CReMA 7 Not environmental Not environmental CEA 10/CReMA 13 CEA/CReMA 7 CEA/CReMA 4</p>

272	Energy conservation Advanced Technology Vehicles Manufacturing Loan Program Energy efficiency and renewable energy	CEA 10/CReMA 13 CEA 10/CReMA 13
274	Emergency energy preparedness Energy preparedness	Not environmental
276	Energy information, policy, and regulation Department of Energy, departmental management OIG, EIA administration Nuclear Regulatory Commission (NRC) Federal Energy Regulatory Commission fees and recoveries, other	Not obvious environmental

There are also a few other potentially environmentally related items contained in other functions in the budget (as shown in Table 2b), which would require further detail to identify how much would classify as environmental as its primary purpose. The following is a short list that was identified based on the name of the function or agency name:

450 Community and Regional Development	
453	Disaster relief and insurance - Disaster relief - National flood insurance fund
050 National Defense	
051	Department of Defense—Military - The Department of Defense Environmental Restoration Accounts
053	Atomic energy defense activities - Defense Environmental Cleanup
550 Health	
551	Health care services - Agency for Toxic Substances and Disease Registry, Toxic Substances and Environmental Public Health
250 General Science, Space, and Technology	
252	Space flight, research, and supporting activities - NASA - Construction and Environmental Compliance and Restoration

3.B. A Practical Approach to Government Environmental Expenditures Based on National Income and Product Accounts (NIPA)

The BEA’s NIPA tables include the government accounts for the United States. Specifically, Table 3.15.5 “Government Consumption Expenditures and Gross Investment by Function” provides statistics for the consolidated government sector as a whole and then separately for the Federal government level, and for the State and local government levels combined. See Figure A1 in the Appendix for an example of what the published table looks like from 2009-2012. For the consolidated government and the federal government level, the category ‘Natural resources’ is included as a sub-function under the main function, Economic Affairs. The natural

resources sub-function is also shown for the state and local levels. In addition, as sub-functions under the main function Housing and community services, the expenditures for Water, Sewerage, and Sanitation are shown highlighted in Figure A1, which shows Table 3.15.5 Government Consumption Expenditures and Gross Investment by Function from the February 2014 Survey of Current Business BEA publication.

Table 3 – Total government consumption expenditures with environmentally relevant subcategories by function – extract from NIPA Table 3.15.5 Government Consumption Expenditures and Gross Investment by Function (Millions USD)

	Year	2016	2017	2018	2019
Line					
Gross Domestic Product (Nominal)		18,745,075	19,542,980	20,611,861	21,433,226
Government	1	3,299,284	3,407,015	3,595,161	3,747,874
Economic Affairs	12	501,798	515,667	541,712	563,525
Other Economic Affairs	19	156,522	158,345	165,736	173,083
Energy	22	38,425	37,508	39,495	39,651
Natural Resources	23	53,501	52,922	52,778	56,465
<i>Government Energy + N.R. subtotal</i>		91,926	90,430	92,273	96,116
Federal	41	1,234,705	1,263,858	1,339,449	1,419,151
Economic Affairs	52	166,978	170,044	177,754	185,165
Other Economic Affairs	59	94,445	95,423	99,809	104,355
Energy	62	27,657	26,603	28,055	26,816
Natural Resources	63	28,890	28,659	27,432	30,595
<i>Federal Energy + N.R. subtotal</i>		56,547	55,262	55,487	57,411
State and Local	78	2,064,579	2,143,157	2,255,712	2,328,723
Economic Affairs	88	334,820	345,623	363,958	378,360
Other Economic Affairs	94	62,076	62,922	65,927	68,729
Energy	97	10,768	10,905	11,440	12,835
Natural Resources	98	24,610	24,263	25,346	25,870
<i>State & Local Energy + N.R. subtotal</i>		35,378	35,168	36,786	38,705
Housing & Community Services	100	53,706	57,325	61,360	64,657
Water	101	18,379	18,941	19,880	21,753
Sewerage	102	19,411	20,089	21,388	22,598
Sanitation	103	9,926	11,796	13,662	13,814
<i>State & Local Water, Sewerage, Sani. subtotal</i>		47,716	50,826	54,930	58,165

Based on the categories selected from NIPA Table 3.15.5, a preliminary extraction of the relevant functions (which were highlighted in yellow in Table 3.15.5 in Figure A1 for illustration) has been made into Table 3 above. The Energy subfunction was included since some of these expenditures would be included in an environmental activities account if these could be separated from the non-environmental ones, as this would be a line item that more closely resembles the

example from the introduction where only a portion of the total expenditures would be primarily environmental in scope. Table 3 shows several recent years to illustrate how these subtotals arise from within the NIPA Table 3.15.5.

Table 4 shows an initial, non-comprehensive environmental activity account for government expenditures (by environmental domain) for the United States based on existing data. In this case, a more conservative approach was taken, and the Energy subfunction was not included because no distribution key has been developed to identify the environmentally relevant portion of the broad Energy subfunction (much of which does not meet the criterion of environment protection/management being its primary purpose). Thus, these figures could be considered a lower bound for the U.S. government's environmental protection and resource management expenditures. Only 3 of 15 CEA categories can be identified distinctly – all other expenditures are grouped together under the “Unclassified – mixed categories” entry in the table. To build a more accurate accounting of government environmental protection and resource management expenditures, the coarse categories such as Energy or Natural Resources need to be subdivided into finer categories that align more neatly with 12 of the 15 CEA categories discussed above. This would require reporting among U.S. federal, state, and local governments to conform closer to COFOG classifications or the 15 CEA categories, which is not currently the case. In the next subsection, we return to this point by discussing some further reporting issues at the state and local levels.

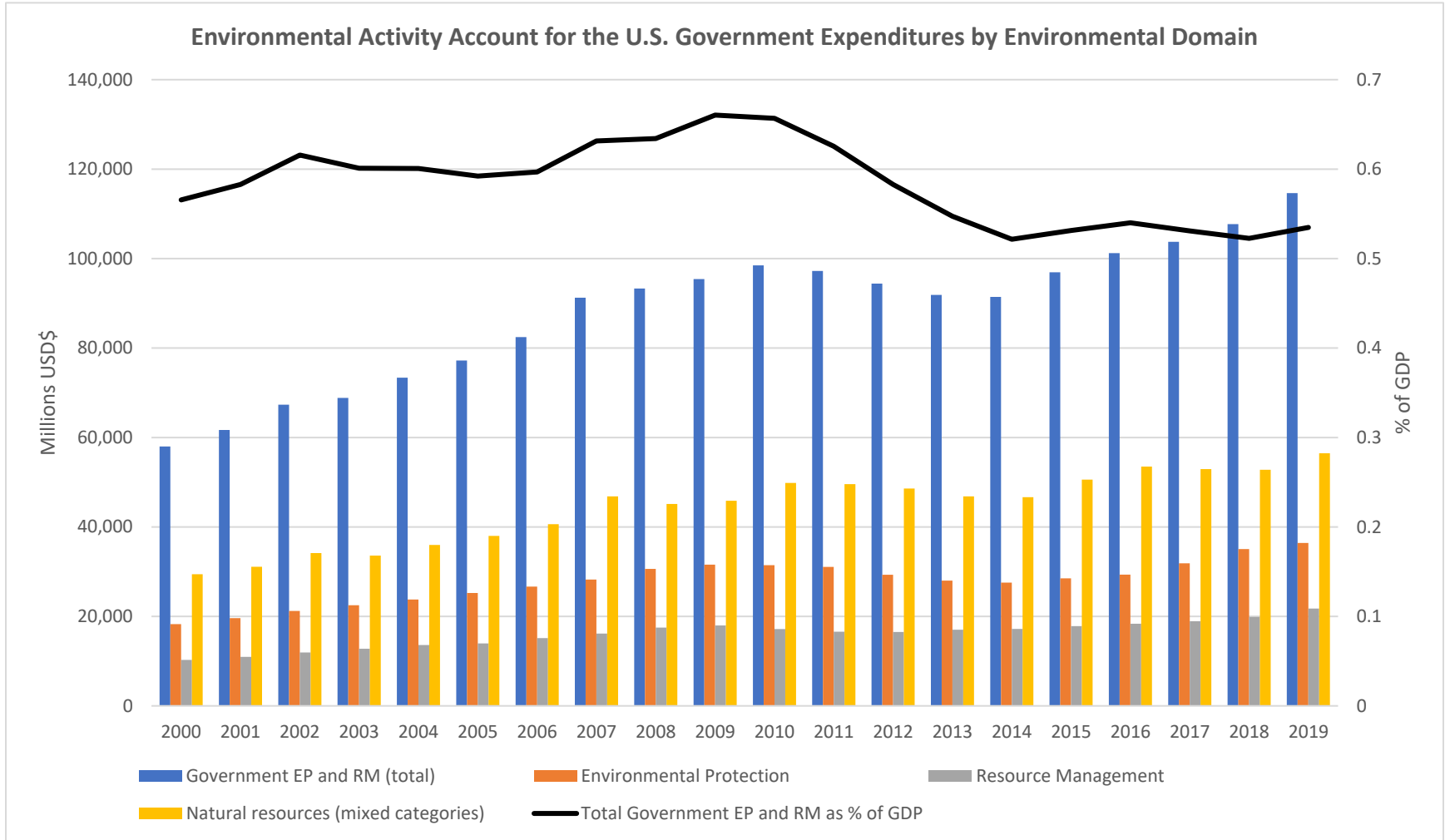
While preliminary, this pilot account reveals information about public sector environmental economic activity that might not be obviously gleaned from standalone, disjointed data. One of the key takeaways from Tables 3 and 4 is the importance of the state and local governments' expenditures on items like wastewater management, waste management and management of water resources – about half in most years. When we compare this to other OECD countries using the IMF Climate Change Indicators Dashboard, for example, this ratio does not seem drastically out of line with the experiences of other countries. So, while this initial account is far from comprehensive and likely represents a lower bound, it shows that one of the main roles governments play in environmental protection and resource management is through its management of water and waste. To the extent that this relates to climate specifically, we revisit this point later in the paper. These initial estimates would indicate that a closer look into how these

Table 4 - Environmental Activity Account for the U.S. Government by Environmental Domain – nominal estimates (millions USD\$)

	Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Line*											
Government EP & RM (total)	-	98,471	97,231	94,405	91,874	91,421	96,928	101,217	103,748	107,708	114,630
<i>I. Environmental Protection</i>	-	31,452	31,082	29,299	28,014	27,565	28,498	29,337	31,885	35,050	36,412
2 Wastewater management	102	20,980	20,602	18,868	17,931	17,931	18,744	19,411	20,089	21,388	22,598
3 Waste management	103	10,472	10,480	10,431	10,083	9,634	9,754	9,926	11,796	13,662	13,814
<i>II. Resource Management</i>	-	17,167	16,567	16,511	17,039	17,196	17,833	18,379	18,941	19,880	21,753
14 Management of water resources	101	17,167	16,567	16,511	17,039	17,196	17,833	18,379	18,941	19,880	21,753
<i>Natural resources – mixed categories</i>	23	49,852	49,582	48,595	46,821	46,660	50,597	53,501	52,922	52,778	56,465

*Line refer to the corresponding lines in the NIPA Table 3.15.5 - Government Consumption Expenditures and Gross Investment by Function, while the categories underlying Environmental Protection (2 & 3) and Resource Management (14) correspond to CEA categories.

Figure 1



figures are obtained is warranted and whether all expenditures lumped into these categories are primarily environmental in their purpose. In addition, the need to identify expenditures in the other environmental domains, and reduce the amount in the mixed category, also add to the necessity to analyze the data collection in more detail below.

Finally, the time series going back to 2000 reveals a familiar phenomenon in national accounts, as the absolute spending levels tell a somewhat different story when contrasted with the proportion to the overall economy (%GDP). While we can see an upward trajectory in absolute spending levels on government protection and resource management categories from 2000 to 2020 in Figure 1, this occurs while the economy is generally growing over the same period. Indeed, Figure 1 also shows that as a percent of GDP, government spending on environmental protection and resource management has been relatively flat over the past two decades (fluctuating above 0.5% and below 0.7%), and even showing slight decline over the past ten years. Overall, while this account is not comprehensive, it illustrates the potential utility of having a time series of a more comprehensive environmental activity account for government protection and resource management expenditures, where decision-makers can evaluate the current state of aggregate spending over time (in an account comparable to other accounts within the suite of national accounts as well as other countries who construct a similar account using similar methods).

3.D. Data collection for State and Local (County, Municipal) expenditures and revenues: Additional Impediments and Opportunities

If environmental protection and natural resource management categories were to be established as part of the classification of functions of government for the U.S., then the public sector accounting and the data collected from state and local governments would likely also need to reflect these changes. While we have already discussed the heterogeneity of the federal budgeting systems, and the impediments they present, the tables above show that state and local governments expenditures have a large role to play, too. Hence, to figure out if, or to what extent, there are already data being reported from the state and local levels that could be used to establish environmentally related expenditures, we examined the reporting from these levels of government in some detail. The reason for examining the variables being reported is simply that if the information is not being reported at the most detailed level, then the information is often not easily available and could require the Census or BEA to establish new or revamped reporting relationships with state and local governments to meet the needs of formal environmental activity

accounts. Often there are aggregations of variables that are used in the development of statistics and the detail is lost – so it is important to examine the detailed reporting. At the current time, it appears that the information about the environment reported at the state and local level are being aggregated into other categories, with the exceptions of water, wastewater and waste treatment, and a potential aggregated category ‘natural resources.’ On the other hand, from a closer examination of the data available from Census regarding expenditures by states, there appears to be some possibilities of developing some more detailed state level statistics.

In Annex A1, we document more specific local and state government reporting issues to Census, which is the primary agency responsible for collecting and processing state and local government data before sending them to the BEA for inclusion in the national accounts and NIPA. The conclusion from this review is that CEA EP-2 Wastewater treatment, CEA EP-3 Solid waste management, and CEA RM-10 Water management are able to be identified and reported with fairly good correspondence between the CEA (CEPA/CR_eMA) definitions and the Census reporting categories.²⁰ This is an important quality check given the prominence of these categories in the total government environmental expenditures reported in the previous subsection. We also flag a number of more specific points in Annex A to help inform how reporting and classifications could be changed (or what underlying data could be obtained from state and local governments) to provide a better mapping to international practices for constructing environmental activity accounts in the US.

Overall, examining both the local government summary tables and the state government detailed data may be a fruitful approach for establishing some initial government finance statistics related to the environment. However, the statistical work performed for developing the government finance accounts could make using the data reported directly to Census for EP and RM accounts different from the official government figures published by Census in these summary tables and from the national accounts/NIPA tables. An initial set of figures with four categories, as shown in Table A3 in the Annex, could be developed using the annual Census summary tables in conjunction with the BEA NIPA tables to ensure consistency. There are Census state and local government finance tables for 1994-2018 estimated for each of the 50 states and a total U.S. figure. To get more detail than this would require developing distribution keys for the different

²⁰ For reference, we briefly summarize the categories and definitions of CEA (CEPA/CR_eMA) in Annex A2.

environmental domains included in the natural resource category, as well as for the environmentally relevant portions of other categories as discussed earlier when investigating the budgeting and reporting variables.

4. Private Sector

The private sector, like the government sector, is both a supplier and a user of environmental goods and services. Private sector purchases of environmental goods and services are considered expenditures, which represent the demand side of the economy. Conversely, the supply side would be all of the goods and services produced by firms for its own-use (called ancillary production) or for sale to others – firms, government, and households. Both the supply and demand/use of the economy are needed to create the environmental protection expenditure accounts reported to Eurostat by members of the European Statistical System. Typically, European countries need to conduct surveys of firms to collect the data necessary for reporting environmental protection expenditures and the environmental goods and services sector to Eurostat. These statistics are the main data used to construct statistics for the supply and demand/use of the private sector part of the environmental economy. In this section of the paper, we briefly summarize these accounts and discuss what opportunities and impediments exist for the U.S. in terms of both public and private sector data.

4.A. Environmental Protection Expenditures by Industry and Households

From 1973-1993, the U.S. produced detailed data on pollution abatement costs and expenditures.²¹ The final year that survey was conducted was 2005.²² Pollution abatement capital expenditures and operating costs in the mining, manufacturing and electric power generation industries were collected according to three media, air, water and solid waste. This facilities-level data allowed for detailed pollution control and cost benefit analyses by the U.S. EPA and was also used for policy analysis.²³ Internationally, collecting detailed firm-level data, as we discussed in section 2, is still commonplace and one of the main ways that countries in the EU, for example, populate environmental activity accounts. Or, to take another example, Statistics Canada employs

²¹ <https://www.epa.gov/environmental-economics/previiously-published-pace-survey-data-1973-1993>

²² <https://www.epa.gov/environmental-economics/pollution-abatement-costs-and-expenditures-2005-survey#History>

²³ See for example the report to Congress: <https://www.epa.gov/clean-air-act-overview/benefits-and-costs-clean-air-act-1970-1990-retrospective-study>

its Annual Survey of Environmental Goods and Services, where the 2020 version of the report contained 100 questions about the firm and its activity related to the environment.

The question then is how to find reliable information on these private expenditures for national environmental accounts. Given that the U.S. already surveys the private sector for current national accounts (e.g., its international surveys on U.S. Direct Investment Abroad), one option is to either create a new survey for the private sector or expand existing surveys to populate these additional accounts. However, Moyer and Dunn (2020) and Abraham et al. (2019) summarize recent efforts by the BEA and statistical agencies throughout the US government who have used “Big Data” and other non-traditional (non-survey/questionnaire based) data as a way to supplement or even replace traditional survey-based methodologies and data sources. This is motivated by a number of different factors, including substantial compliance and administration burden costs, which fuel worries by statistical agencies that survey response rates will continue to fall as they have in recent decades (Jarmin 2019); and, as a result, traditional survey data may become less reliable or representative.

Given concerns about the substantial compliance and administration burden with a survey approach, another option is to consider information firms already disclose publicly through alternative sources, such as sustainability reports, proxy reports, and 10-Ks. As 96 (80) percent of the largest (large and mid-cap) firms around the world now publicly report on sustainability (KPMG, December 2020), this suggests that public information may be a viable source of information for national accounts in the future.²⁴ However, there are at least two challenges with this option. First, for U.S. companies, disclosures about environmental expenditures are largely voluntary, whereby subsets of firms may not report this information and those that do report on it may substantially vary the set of information they provide and the way they are presented. For example, as discussed in Boffo and Patalono (2020), coverage and potential reporting may be concentrated in larger market cap companies and leave out smaller firms with less resources for reporting. Additionally, if we look at these reports (for example, comparing ExxonMobile’s report with Chevron), one can see just how different climate and sustainability related reports can look

²⁴ The large firms sample (labeled “G250”) is based on the world’s 250 largest companies by revenue as defined in the Fortune 500 ranking of 2019. The large and mid-cap firm sample (labeled “N100”) is based on a worldwide sample of 5,200 companies that represent the top 100 companies by revenue in each of the 52 countries and jurisdictions captured in the study.

even in comparison of two large U.S. firms within the same industry, where the environmental concerns are likely to have greater overlap. For instance, while both reports discuss investments in lower-emission energy solutions for large U.S. energy companies, the environment related expenditures referenced in the two reports correspond with very different (and long) time horizons and are presented in very different formats in terms of narrative versus graphical representations.²⁵

The second challenge is that there is not a standardized definition of precisely what activity firm reported expenditures should contain nor is there is a consistent enforcement mechanism to ensure values adhere to particular types of activity.²⁶ As such, it is difficult to evaluate how well the expenditures firms currently report align with the parameters needed for national accounts. For example, national accounts inherently have an interest in the geographic bounds of the related activity whereas many firms may only report environmental expenditures on a consolidated, worldwide basis. Additionally, national accounts may call for a distinction between different classes of activity, such as expenditures for wastewater management versus ambient air and climate in line with the classes outlined within the System of Environmental-Economic Accounting (SEEA).²⁷ In contrast, companies may disaggregate expenditures on different aspects of the environment or may not disaggregate their environmental expenditure values at all.

Consistent with the challenges above in terms of the lack of standardized reporting on ESG, vendors that provide ESG ratings based on public information, such as MSCI, Sustainalytics, Bloomberg, Thomson Reuters Refinitiv, and RobecoSAM, often diverge in how they rate companies (Boffo and Patalono 2020). Further, to the best of our knowledge, only the Refinitiv data provides subscribers with underlying data on some of the environmental expenditures firms make. In contrast, most of these vendors only offer company level ESG ratings or scores, indicators

²⁵ ExxonMobil provides a narrative reference to \$10 billion in research and development for this purpose over 2000-2020 (Exhibit A, p. 34) while Chevron presents a tabular graphic noting a \$2 billion investment in carbon reduction projects by 2028 (Exhibit B, p. 2).

²⁶ There is a multitude of different frameworks and guidelines for firms to consider with their ESG reporting. For example, the following provide various disclosure frameworks: the Carbon Disclosure Project (CDP), Climate Disclosure Standards Board (CDSB), Global Reporting Initiative (GRI), International Integrated Reporting Council (IIRC), and Sustainability Accounting Standards Board (SASB). GRI remains the most commonly used reporting standard or framework where KPMG reports that two-thirds (three-quarters) of its large (large and mid-cap) firm samples use this framework for their reports (KPMG, December 2020).

²⁷ See Annex 3 in Eurostat (2017) for a more complete list outlined with the Classification of Environmental Protection Activities (CEPA).

for whether certain activity is relevant for the company (e.g., whether it has an environmental management system or provides a CSR report), and other company identifying information.

One step that could overcome many of the challenges above with using publicly reported information for national accounts could evolve from: (1) integration of mandatory sustainability disclosure standards in financial reporting standards for U.S. firms and (2) incorporation of the need for national environmental accounts as a factor in determining the bounds of information reported. Standardized definitions and representations of environment related expenditures by firms could substantially reduce resources needed by current vendors or government agencies to gather this information. Further, from the perspective of the firms reporting this information, it would negate the need for them to fill out lengthy surveys that solely serve to inform national accounts. Instead, the standardized public information could respond to a growing demand by investors and other market participants for public information on climate change. In particular, recognizing the dramatic increase in public demand for information around climate change, the U.S. Securities and Exchange Commission (SEC) has called for public comment on climate change disclosures and an evaluation of how the SEC can best “regulate, monitor, review, and guide climate change disclosures in order to provide more consistent, comparable, and reliable information” for investors and other market participants (U.S. SEC, March 15, 2021). In line with this objective, mandatory, standardized disclosure that encompasses the SEEA framework for environmental accounts used by many other countries for environmental accounts could enhance comparability of these accounts across nations for discussions regarding climate in years to come.

4.B. Environmental Goods and Services Sector (EGSS)

Supply-side statistics for environmental goods and services are published by Statistics Canada and by member states of the European Statistical System and Eurostat. The European system uses CEPA and CReMA classifications, NACE, and indicative lists of environmental goods and services for the development of the country-level statistics. Statistics Canada takes a more focused approach publishing Environmental and Clean Technology Products Economic Account (ECTPEA). Australia produces waste and water accounts and part of these accounts. Expenditures on waste services by industries, government, and households, plus employment and gross value added of the waste services industry are published as part of the waste and water accounts and not as separate monetary environmental accounts.

Given that the Eurostat approach is well-developed and established, we began work on translating the Eurostat approach to the U.S. system by using indicative lists of industries producing environmental products and services.²⁸ Although there are official conversion tables from NACE industry groups to NAICS industry groups, we found that making this conversion for the environmental portion of the NACE may map to a different NAICS category than is specified in the high level conversion tables. In order to do this properly, a careful reading of the descriptions of the activities included in the NAICS categories was necessary in order to find the correct categories containing the environmental products and activities specified in the Eurostat list. One advantage of the NAICS data for this particular purpose, we found, was that there were a number of activities that were not specified in the Eurostat list but were described in the NAICS. Thus, our preliminary work on evaluating the feasibility of following the Eurostat approach for the US leads us to conclude that this cross-walk is possible. But, we found that the real challenge is not categorical or just with constructing a cross-walk and subsequent assembly of the corresponding tables. Recall that for an activity to be “environmental” it must be environmental in its primary purpose, and there are numerous categories that are less than fully environmental in their primary purpose. Thus, we found that the real challenge is determining the percentage of each of the relevant 6-digit NAICS industry categories that is the environmental good or service portion of the larger category.

Determining the portion of the 6-digit NAICS that is environmental is the next challenge. Although Eurostat publishes EGSS statistics at a 2-digit NACE level, and the percentage of the NACE category can be back calculated,²⁹ these would only provide rough estimates when having to convert these to NAICS. More detailed 4- or 6-digit NACE percentages are not readily available and, of course, the structure of European economies are not necessarily transferable to the U.S. economy. Additional work will be needed to develop these percentages, either from secondary sources or from survey data. For example, the firm-level databases like Refinitiv could help provide some information about revenues and expenditures in these industries that could be used

²⁸See methodology section for environmental accounts: <https://ec.europa.eu/eurostat/web/environment/methodology> and then under EGSS find the indicative lists of environmental products and services. For 2021 reporting the file is here: <https://ec.europa.eu/eurostat/documents/1798247/6191549/EGSS+list+of+env+products.xlsx>

²⁹ Eurostat publishes EGSS data using 22 NACE categories, and is combined with national accounts data for GVA, output and employment data. The percent of the categories can be back calculated using the EGSS ratios and the national accounts data.

to estimate some of these percentages needed to construct a more accurate EGSS account. We leave this exercise to future research.

5. Toward defining climate change related expenditures

Given that much of the interest in environmental activity accounts has come from 21st century challenges with environmental policy and climate change, we should again emphasize that environmental economic accounts are not exactly synonymous with climate change statistics.³⁰ That is, all economic activities and expenditures relating to the environment are not related to climate; and when considering environmental expenditure accounts for the purposes of climate-related decisions or policies, national statistical offices who produce these accounts should be clear that only a subset of these expenditures specifically relate to climate. Environmental adaptation expenditures in Hawaii, for example, related to volcanic activity have little, if anything, to do with meteorological climate change. Disaster expenditures related to earthquakes in California, to take another example, might be environmental in their primary purpose, but do not relate to climate directly. So, while there is often significant overlap, given the size and scope of climate change as it is defined by international organizations like the UN's International Panel on Climate Change (IPCC), it is important to delineate between environmental and climate expenditures if one of the purposes of these accounts is to use this information to guide decision-making on these issues. In this section, we discuss what this delineation would look like, both conceptually and practically, and the subsequent implications for data collection efforts for climate change expenditures in particular.

5.A Isolating Climate Change Expenditure from Environmental Expenditure: Conceptual Issues and Challenges

In attempting to define and identify climate change related expenditures, we should first outline how these are linked to two other relevant concepts with potentially overlapping systems and definitions: 1) Environmental Protection Expenditures (EPE) and Resource Management

³⁰ We should make another important distinction when we compare environmental economic accounts to climate statistics. Unlike SEEA-based accounts, there is not yet an international standard for what constitutes "climate statistics," or settled definitions and classifications of activities as "climate-related," nor a consensus definition of what falls under the scope of climate change. In this regard, one can read this section of the paper as more exploratory, as methods for climate statistics are far less established.

expenditures (RM) ³¹ and (2) Disaster/hazard related expenditures.³² The SEEA-CF helps delineate which aspects of climate change are included as part of environmental protection expenditure. As we have discussed in prior sections, the SEEA-CF defines environmental activity accounts which include both environmental protection and resource management expenditures. An IDB analysis³³ has also concluded that starting with the established classification systems of CEA and COFOG are important so that any new classification developments are able to be connected easily into established statistical systems and the national accounts. Specifically, Category 1 of the Classification of Environmental Activities (CEA) (see SEEA-CF Annex I) is the Protection of Ambient Air and Climate which includes climate change mitigation. Climate change adaptation in particular is not considered part of EPE/RM expenditures, "...economic activity associated with adaptation to climate change is not considered an environmental activity per se" (SEEA-CF para 4.23). Given this delineation, the relationship between CEA and Climate Change can be depicted as in Figure 2A.

Both Germany (Destatis)³⁴ and Norway (SSB)³⁵ publish figures for climate protection expenditures. Germany shows investments split by renewable energy use, higher energy efficiency and energy savings, and prevention and reduction of Kyoto greenhouse gases. Norway splits CEPA-1 Protection of air and climate into two categories and has data for current expenditures, ancillary output, intermediate consumption, and investments related to climate protection. So here are examples of countries already attempting to develop climate related expenditure statistics but exactly what is included or excluded is unclear, although it is most likely these are only SEEA-CF climate mitigation expenditures.

Climate change financing and budget tagging systems generally include adaptation and mitigation perspectives.³⁶ However when developing a new system one important consideration

³¹ Page 14, 18-19, IADB <http://dx.doi.org/10.18235/0003021>

³² Climate change statistics generally use two main concepts: adaptation and mitigation. Mitigation is defined by the IPCC as, "A human intervention to reduce emissions or enhance the sinks of greenhouse gases" and adaptation is defined as, "the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities." Glossary – Annex VII of IPPC AR6 WGI https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Annex_VII.pdf

³³ IDB (2021) <https://publications.iadb.org/publications/english/document/Climate-Change-Public-Budget-Tagging-Connections-across-Financial-and-Environmental-Classification-Systems.pdf>

³⁴ https://www.destatis.de/EN/Themes/Society-Environment/Environment/Environmental-Economics/_node.html

³⁵ <https://www.ssb.no/en/statbank/table/13062>

³⁶ OECD (2021), *Green Budget Tagging: Introductory Guidance & Principles*, OECD Publishing, Paris, <https://doi.org/10.1787/fe7bfcc4-en>;

is how the terms are currently being used more generally so that important aspects are not overlooked.³⁷ In the case of climate change expenditures, the use of the term “climate disasters” is being used in the popular press more often and also by the US government – see for example NOAA’s national centers for environmental information time series for “Billion-Dollar Weather and Climate Disasters” (<https://www.ncdc.noaa.gov/billions/>). Hence, disaster/hazard risk related expenditures are currently being discussed and developed as part of an international working group under the UNDRR and led by UNESCAP Statistics Division.

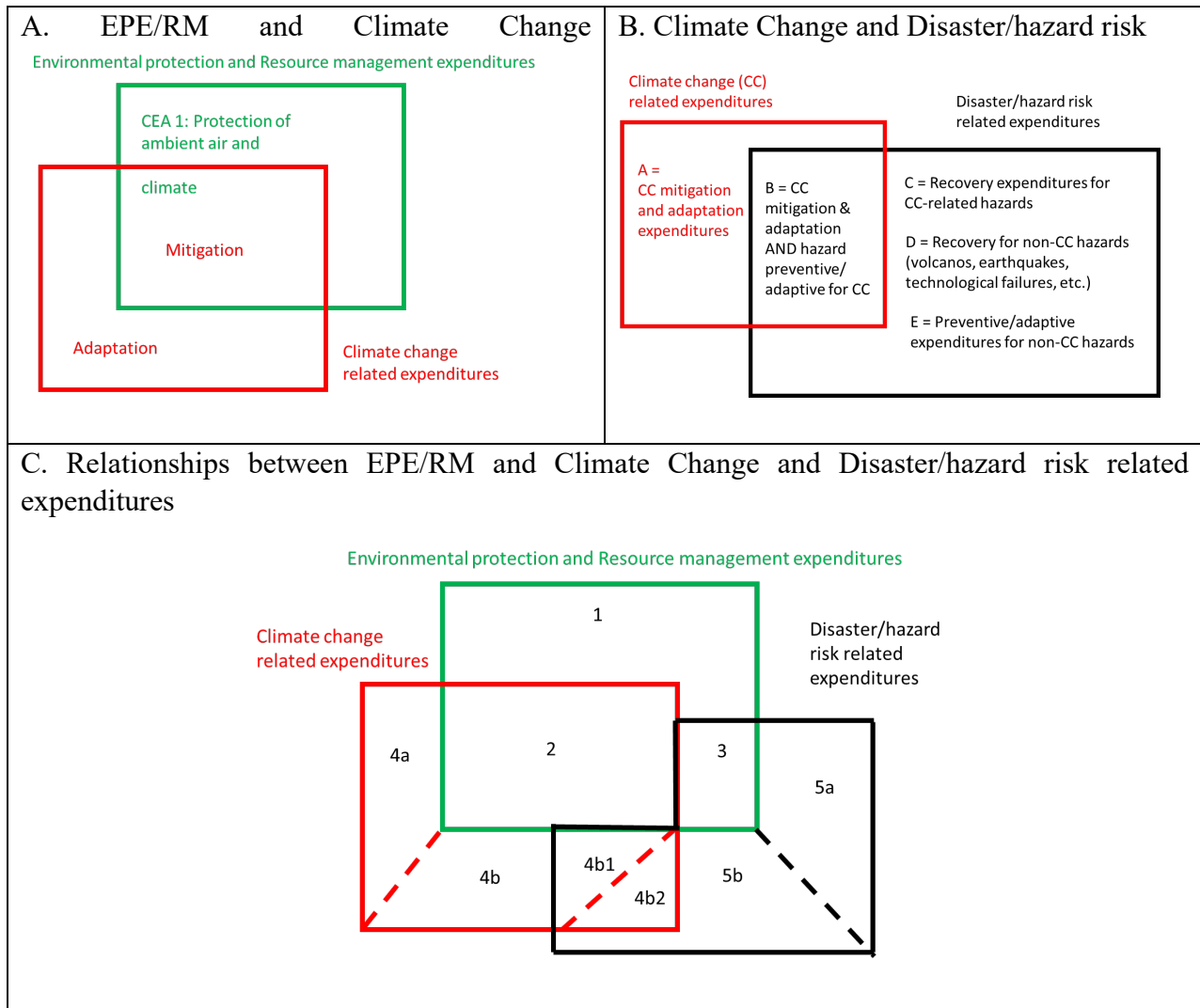
In the disaster/risk reduction field there are two main concepts, recovery and preventive/adaptive. Some of the expenditures that are disaster preventive/adaptive that are relevant to climate change would overlap as climate change expenditures. When considering the NOAA billion-dollar climate disaster context mentioned above, the focus is on “recovery” after extreme climate related disaster events. So, these would be classified as both climate and disaster expenditures. As we illustrate in Part A in Figure 2, the relationships between climate change expenditures and disaster/hazard expenditures are also a subset shown in Figure 2B.

Given the delineation illustrated in boxes A and B in Figure 2, we combine all three of these separate, but overlapping concepts, into a single framework that could be used to develop a combined Climate/Disaster/Environmental Protection/Resource Management classification of expenditures. Figure 2C shows a proposed merging of the three inter-related, overlapping concepts followed by a table with short descriptions of the different areas in Figure 2C. This illustrates these overlapping concepts and shows how creating a comprehensive classification could be useful when trying to cover all of these different environmental aspects of these kinds of expenditures. Conceptually, this illustration helps reduce the problem of double counting if each of these three important areas develop their own separate, mutually exclusive definitions and statistical frameworks along these borders.

EU Technical Expert Group on Sustainable Finance (March 2020), Technical annex to the TEG final report on the EU taxonomy https://ec.europa.eu/info/files/200309-sustainable-finance-teg-final-report-taxonomy-annexes_en

³⁷ Need to avoid what happened when the EPE was established, and energy savings were excluded. At the time everyone considered that energy savings was an environmental protection expenditure. This mis-match has been addressed with the development of resource management expenditures – where energy savings are part of this aspect of environmental activity accounts.

Figure 2. Relationships between expenditures related to EPE/RM, climate change, and disaster/hazard risk.



AREA DESCRIPTIONS FOR FIGURE 2 – CLIMATE AND NON-CLIMATE CHANGE CLASSIFICATIONS

1	EPE-RM but not climate mitigation or disaster/hazard-related
2	EPE-RM which are also CC mitigation but not disaster/hazard related
3	EPE-RM which are also disaster/hazard recovery and adaptive/preventive related
4A	CC Adaptations to the natural environment that are not EPE-RM expenditures (do not have environmental protection or resource management as ‘primary purpose’)
4B	CC Adaptation of human systems that are not EPE-RM or disaster/hazard related
4B1	CC Adaptation of human systems that are also disaster/hazard recovery related

4B2	CC Adaptation of human systems that are also disaster/hazard adaptive/preventive related
5A	Disaster/hazard adaptive/preventive related that are not related to climate or EPE-RM (primary purpose)
5B	Disaster/hazard recovery related that are not related to climate or EPE-RM (primary purpose)

5.B. Which hazards are climate change related? A brief summary of recent work

The next issue is determining which disasters/hazard risks are climate change related. Under the auspices of the Sendai Framework for Disaster Risk Reduction 2105-2030, a technical working group of the UNDDR and International Science Council have recently released a technical report on hazard definition and classification.³⁸ This proposed classification has undergone extensive consultations and has been developed as a relational rather than a hierarchical classification. This means that how something is first classified determines the entry point to the system. A relational classification system can take advantage of relational data systems rather than the more traditional hierarchical systems. But this means that the groups do not aggregate in a specific manner. There are three levels in the Hazard classification system: Type, Cluster, and Specific Hazard. The 8 types are:

- | | |
|------------------------------------|------------------|
| 1. Meteorological and hydrological | 5. Chemical |
| 2. Extraterrestrial | 6. Biological |
| 3. Geohazard | 7. Technological |
| 4. Environmental (degradation) | 8. Societal |

But which of these types of hazards are considered to be due to climate change? The EU Technical Expert Group (TEG) on Sustainable Finance has developed an EU Classification of climate related hazards.³⁹ thus defining which hazards are due to climate change.

³⁸ <https://www.undrr.org/publication/hazard-definition-and-classification-review>

³⁹ EU Technical Expert Group (TEG) on Sustainable Finance (2020), EU taxonomy report, Technical Annex, Table 5 page 28.
https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/200309-sustainable-finance-teg-final-report-taxonomy-annexes_en.pdf

Table 5. EU Classification of climate-related hazards

	WATER-RELATED	WIND-RELATED	TEMPERATURE-RELATED	SOLID MASS – RELATED
CHRONIC	Changing precipitation patterns and types (rain, hail, snow/ice)	Changing wind patterns	Changing temperature (air, freshwater, marine water)	Coastal erosion
	Precipitation and/or hydrological variability	-	Heat stress	Soil degradation
	Ocean acidification	-	Temperature variability	Soil erosion
	Saline intrusion	-	Permafrost thawing	Solifluction
	Sea level rise	-	-	-
	Water stress	-	-	-
ACUTE	Drought	Cyclone, hurricane, typhoon	Heat wave	Avalanche
	Heavy precipitation (rain, hail, snow/ice)	Storm (including blizzards, dust and sandstorms)	Cold wave/frost	Landslide
	Flood (coastal, fluvial, pluvial, ground water)	Tornado	Wildfire	Subsidence
	Glacial lake outburst	-	-	-

Source: EU Technical Expert Group (TEG) on Sustainable Finance (2020), EU taxonomy report, Technical Annex, Table 5 page 28.

https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/200309-sustainable-finance-teg-final-report-taxonomy-annexes_en.pdf

Unfortunately, the EU classification of climate-related hazards is not based on the international UNDRR Sendai system, so developing a crosswalk between these two systems would be necessary. One practical challenge in developing a correspondence is that the UNDRR system does not have the dimensions chronic/acute so this will need to be considered when making the conversion. The EU classification helps to identify climate-related hazards, which in turn can be used to define system boundaries. Sorting out the overlapping concepts between these three systems is helpful to see how they can be related. The next step would be figuring out how to determine whether an expenditure should qualify as one to be included.

5.C. Practical challenges in designating expenditures as climate-related: in or out?

Recall that the inclusion criterion as defined in the SEEA-CF for EPE/RM activity accounts is “primary purpose.”⁴⁰ Using the primary purpose criterion, at least some of the activities associated with the minimization of the impacts of natural hazards on the economy and human systems would already be included in environmental protection expenditures (SEEA-CF, §4.22). Climate change mitigation expenditures would also be included using this criterion. Thus, one overarching practical challenge is how to determine if a given environmental expenditure, whose “primary purpose” is already environmental, is also climate-specific. The examples in the introduction to this section make the line clear, ruling out earthquake and volcanic related environmental expenditures for instance, but the classification of other activities becomes less clear.

The recent EU effort takes on this challenge. The EU’s Taxonomy Regulation came into force in July 2020 and will be part of the Non-Financial Reporting Directive which covers large public-interest companies with more than 500 employees. The EU taxonomy is a classification system, establishing a list of environmentally sustainable economic activities.⁴¹ Whereas mitigation activities can typically be identified, and a standalone, exhaustive list developed, adaptation activities and related expenditures are context specific. The EU advises that, “Instead of a list of adaptation activities, a set of guiding principles and screening criteria is used to assess the potential contribution of an economic activity to adapt to climate change and increase climate resilience.”⁴² The decision trees for use with the taxonomy are provided in the annex to this paper. What is not included with either the primary purpose or some other selection criteria outlined by

⁴⁰ SEEA-CF (2014) Environmental Protection Expenditure: §4.12 “*Environmental protection activities are those activities whose primary purpose is the prevention, reduction and elimination of pollution and other forms of degradation of the environment*” and Resource Management: §4.12 “*Resource management activities are those activities whose primary purpose is preserving and maintaining the stock of natural resources and hence safeguarding against depletion.*”

⁴¹ Specifically, it says: “The EU taxonomy would provide companies, investors and policymakers with appropriate definitions for which economic activities can be considered environmentally sustainable. In this way, it should create security for investors, protect private investors from greenwashing, help companies to become more climate-friendly, mitigate market fragmentation and help shift investments where they are most needed.” https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en

⁴² EU definitions from Technical Annex to TEGs:

https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/200309-sustainable-finance-teg-final-report-taxonomy-annexes_en.pdf

the EU are “expenditures for activities that have a significant effect on climate change but are not explicitly intended to deal with climate change.”⁴³ The problem with using the EU taxonomy is the fine granularity of data and information required to make an evaluation – project level data are needed not budget level data.

The Technical Annex of the EU TEG Taxonomy Report⁴⁴ provides very specific examples, by NACE codes, of how the taxonomy should be applied. For example, for NACE 23.5.1 Manufacture of Cement CO₂ emissions limits are specified per metric ton of cement or binder. If the thresholds are met, then the production changes (operating and capital investments) made to achieve the threshold can be considered as climate relevant. These types of detailed evaluations are possible at the production facilities but are not possible to use when evaluating industry level data.

This makes the EU taxonomy difficult to apply at an industry or government agency level because much of the current data is not sufficiently fine-grained to accommodate this narrow of a definition. If the company level reporting to this EU Directive are detailed enough, this may be a future source of data for developing statistics. This is also the case for the recently published ISO international standard, ISO/DIS 14030, Environmental performance evaluation for Green debt instruments and the associated taxonomy.⁴⁵

For analysis at a government level, a number of budget tagging procedures have been developed, such as the ones at the World Bank, OECD, and UNDP.⁴⁶ These guidelines are using a country’s own climate policies to determine whether a budget line is considered climate related or not. These are more descriptive than prescriptive. The challenge for identifying and segregating expenditures related to climate, environmental protection, resource management, risk management, and disaster recovery, is that the relevant figures can be found in a few dedicated

⁴³ IDB (2021) page 26. <https://publications.iadb.org/publications/english/document/Climate-Change-Public-Budget-Tagging-Connections-across-Financial-and-Environmental-Classification-Systems.pdf>

⁴⁴ https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/200309-sustainable-finance-teg-final-report-taxonomy-annexes_en.pdf

⁴⁵ <https://www.iso.org/news/ref2716.html>

⁴⁶ World Bank (2021) “Climate Change Budget Tagging: A Review of International Experience” EFI Insight-Governance. Washington, DC: World Bank (<http://hdl.handle.net/10986/35174>). OECD (2021) *Green Budget Tagging: Introductory Guidance & Principles*, OECD Publishing, Paris, <https://doi.org/10.1787/fe7bfcc4-en>. UNDP (2019) *Knowing What You Spend: A guidance note for governments to track climate change finance in their budgets* (<https://www.undp.org/publications/knowning-what-you-spend-guidance-note-governments-track-climate-change-finance-their>).

agencies, such as FEMA the U.S. Federal Emergency Management Agency, but the expenditures also occur in numerous departments and agencies in the US government.

The OECD has worked on a framework for accounting national risk management expenditures and losses from disasters.⁴⁷ The challenge is finding these types of expenditures since there are multiple agencies and levels of government – not unlike environmental protection expenditures. The dimension that the OECD issue paper brings into the discussion is ex-ante and ex-post (a before and after) which may correspond to the UNDRR concepts of preventive/adaptive and recovery but more likely is describing when the expenditure analysis is performed, i.e., before or after a disaster event. The challenges of finding disaster recovery expenditures is especially difficult at the U.S. state and local levels since so many different funding sources are used.⁴⁸

For climate change expenditures (as a subset of environmental activity accounts) to become a reality in the US, it is clear from our research that both conceptual and practical challenges remain. One such conceptual challenge, as discussed above, is to determine what additional selection criteria beyond primary purpose are needed to identify climate change related expenditures and disaster recovery and disaster/hazard risk preventive and adaptive expenditures. And from a practical, data-oriented perspective, the current taxonomies from the ISO and EU require such fine grained, detailed, project-level data that are not useful for company, industry, or government budget level analysis.

6. Discussion

Our research here has shown that existing data in the U.S. can only get us so far in constructing environmental activity accounts. While we documented a number of impediments in the U.S. public sector accounting and budgeting framework, we found that, using existing data from the BEA, we could construct a preliminary environmental activity account for the government's expenditures on environmental protection expenditures and resource management. While incomplete, it illustrates where the low hanging fruit might be for filling in holes in international databased like the IMF's Climate Change Dashboard, which tracks country-level relevant to climate change policy and decision-making. As we explored the feasibility of other

⁴⁷ OECD (2014) <https://www.oecd.org/gov/risk/issues-paper.pdf>
<https://www.oecd.org/gov/risk/improving-the-evidence-base-on-the-costs-of-disasters.htm>

⁴⁸ PEW (2020) <https://www.pewtrusts.org/en/research-and-analysis/reports/2020/05/how-states-pay-for-natural-disasters-in-an-era-of-rising-costs>

types of environmental economic accounts, we found impediments that were more substantial, as we documented data limitations for constructing private sector environmental protection expenditure (EPE) accounts or environmental goods and services sector accounts (EGSS). Finally, we show that tailoring environmental-economic accounts data to climate change specifically is significantly more challenging. We laid out why further methodological work and improvements in the data would be necessary to make more specifically tailored, climate-specific accounts a reality.

In our discussion of data impediments in the private sector and challenges for private sector accounting, we noted that what is often missing from the academic literature's discussion of ESG reporting is how it might be used for macro-purposes, like constructing national accounts from this micro-level firm data. However, we should note that even if firms who do report environmental data as part of their ESG reports were on board with reporting expenditures and revenues in a way that would be consistent with SEEA, we would still have a problem with firms who do not report any ESG data at all. Because this information is often voluntarily disclosed, and firms choose to disclose ESG data for different reasons,⁴⁹ there still may be scope for traditional surveys or other means to fill in the gaps that might still exist if firms harmonized their reporting.

An alternative to this, which is currently being debated in the accounting literature, is mandatory disclosure of ESG activity. But, we should also note that mandatory disclosure alone would not completely solve all of our problems, particularly if it were not tied to standardization of information as we have described above. Conditional on the reporting of ESG activity, a stream of research has evaluated variation in the kinds of information reported and factors that influence this heterogeneity. This type of examination is valuable because it suggests the type of information that may be left out of reports and conveys the degree (or lack there) of comparability within information reported in the absence of mandated (standardized) reporting. For instance, firms with litigation concerns typically reveal more good news than bad news (Deegan and Rankin 1996) and may selectively reveal benign environmental impacts (engage in "greenwashing") (Marquis,

⁴⁹ For example, prior research suggests the size of the firm (Bouten et al. 2012; Thorne et al. 2014), its reliance on external financing (Cormier and Magnan 1999; Dhaliwal et al. 2011), exposure to media attention (Brown and Deegan 1998; Bouten et al. 2012) or litigation and regulatory concerns (Barth, McNichols, and Wilson 1997), and pledges to the U.S. Environmental Protection Agency (Innes and Sam 2008) can influence whether and to what extent firms report on ESG activity. Thus, this research implies that reporting by firms without these pressures or concerns may be the firm activity captured with mandated reporting from a broader set of firms.

Toffel, and Zhou 2016). Additionally, firms employ different language and verbal tone to manage impressions of their environmental performance in their reports (Cho, Roberts, and Patten 2010). Further, industry membership and norms can also play a role in the type of information is reported (Cormier and Magnan 2003; Aerts, Cormier, and Magnan 2006). Aside from the information in the report, firms also differ in terms of whether and what type of assurance audits they purchase, which is at least in part motivated by a need to increase the credibility of their reports (Simnett, Vanstraelen, and Chua 2009). Collectively, this area of research suggests discretion with voluntary reporting may induce certain biases with the information reported, which suggests what types of mandated information coupled with standardization (ideally, consistent with SEEA and the SNA) could enhance the credibility of ESG reporting and would be useful in helping countries like the US (who do not currently survey firms for this information) construct environmental-economic accounts.

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Appendices and Annexes

Figure A1. NIPA Table 3.15.5 Government Consumption Expenditures and Gross Investment by Function

Table 3.15.5. Government Consumption Expenditures and Gross Investment by Function
(Billions of dollars)

	Line	2009	2010	2011	2012		Line	2009	2010	2011	2012
Government	1	3,089.1	3,174.0	3,158.7	3,167.0	Other economic affairs	59	74.2	92.1	81.5	79.8
General public service	2	264.0	266.9	263.5	269.1	General economic and labor affairs	60	7.4	11.5	10.2	7.8
Executive and legislative	3	83.3	85.4	87.6	89.0	Agriculture	61	9.9	13.7	10.7	10.7
Tax collection and financial management	4	54.2	55.6	50.8	54.6	Energy	62	27.7	33.9	27.7	28.9
Other	5	126.5	125.9	125.1	125.5	Natural resources	63	25.9	30.1	30.1	29.8
National defense	6	788.3	832.8	835.8	817.1	Postal service	64	3.3	3.0	2.7	2.5
Public order and safety	7	351.4	353.9	358.1	364.1	Housing and community services	65	1.8	2.1	2.4	2.3
Police	8	154.3	158.1	161.0	163.0	Health	66	128.6	139.4	147.7	156.6
Fire	9	50.8	51.1	50.9	51.2	Recreation and culture	67	5.2	6.0	5.6	5.5
Law courts	10	57.7	58.2	59.4	61.4	Education	68	8.3	8.5	9.1	9.3
Prisons	11	88.7	86.5	86.9	88.5	Elementary and secondary	69	1.5	1.2	1.4	1.1
Economic affairs	12	449.0	468.4	458.6	466.0	Higher	70	1.3	1.4	1.6	1.8
Transportation	13	277.2	282.1	285.3	294.7	Other	71	5.6	5.9	6.2	6.4
Highways	14	212.1	214.4	217.3	224.6	Income security	72	18.0	20.6	17.9	18.1
Air	15	32.0	32.9	32.6	33.6	Disability	73	0.7	0.7	0.7	0.7
Water	16	15.6	17.0	17.7	18.1	Retirement ¹	74	3.0	3.0	2.6	2.7
Transit and railroad	17	17.5	17.7	17.6	18.4	Welfare and social services	75	8.8	11.9	9.5	9.8
Space	18	32.1	32.1	30.5	27.7	Unemployment	76	0.1	0.2	0.2	0.2
Other economic affairs	19	139.6	154.2	142.8	143.6	Other	77	5.3	4.7	5.0	4.7
General economic and labor affairs	20	30.2	33.0	31.8	30.6	State and local	78	1,871.4	1,870.2	1,854.7	1,871.3
Agriculture	21	16.2	20.0	17.3	17.7	General public service	79	199.6	197.7	194.7	196.9
Energy	22	41.4	46.7	39.3	41.0	Executive and legislative	80	35.8	34.9	34.3	34.3
Natural resources	23	47.7	50.8	51.0	51.2	Tax collection and financial management	81	37.4	37.0	35.2	37.1
Postal service	24	3.3	3.0	2.7	2.5	Other ²	82	126.5	125.9	125.1	125.5
Other	25	0.8	0.7	0.6	0.7	Public order and safety	83	293.3	294.3	296.9	301.7
Housing and community services	26	60.5	63.8	58.5	55.4	Police	84	113.9	117.0	118.3	119.6
Health	27	209.5	218.4	226.1	237.3	Fire	85	49.6	50.0	49.8	50.1
Recreation and culture	28	43.3	42.9	41.8	41.6	Law courts	86	48.0	47.8	49.0	50.9
Education	29	828.4	830.9	822.5	822.1	Prisons	87	81.8	79.5	79.7	81.1
Elementary and secondary	30	637.2	636.8	621.3	602.3	Economic affairs	88	304.1	302.7	303.2	313.8
Higher	31	154.9	157.1	164.0	181.9	Transportation	89	238.7	240.6	241.9	250.0
Libraries and other	32	36.3	37.0	37.2	37.9	Highways	90	209.4	211.3	214.1	221.0
Libraries	33	13.2	12.8	12.6	12.7	Air	91	10.2	10.2	9.0	9.0
Other	34	23.1	24.2	24.6	25.2	Water	92	2.0	2.0	2.0	2.5
Income security	35	94.7	96.2	93.8	94.3	Transit and railroad	93	17.0	17.1	16.8	17.5
Disability	36	4.6	4.2	4.1	4.0	Other economic affairs	94	65.4	62.1	61.3	63.8
Retirement ¹	37	3.0	3.0	2.6	2.7	General economic and labor affairs	95	22.8	21.5	21.5	22.8
Welfare and social services	38	81.6	84.0	82.0	82.7	Agriculture	96	6.3	6.3	6.6	6.9
Unemployment	39	0.1	0.2	0.2	0.2	Energy	97	13.7	12.8	11.6	12.1
Other	40	5.3	4.7	5.0	4.7	Natural resources	98	21.7	20.7	20.9	21.4
Federal	41	1,217.7	1,303.9	1,304.1	1,295.7	Other	99	0.8	0.7	0.6	0.7
General public service	42	64.4	69.1	68.9	72.2	Housing and community services	100	58.8	61.7	56.1	53.1
Executive and legislative	43	47.5	50.6	53.3	54.7	Water	101	19.3	19.4	17.5	17.1
Tax collection and financial management	44	16.9	18.6	15.6	17.5	Sewerage	102	21.6	22.7	20.9	20.1
Other	45					Sanitation	103	11.4	10.6	10.3	9.8
National defense	46	788.3	832.8	835.8	817.1	Housing and other	104	6.4	9.0	7.5	6.1
Public order and safety	47	58.1	59.6	61.2	62.4	Health (net)	105	80.9	79.0	78.4	80.6
Police	48	40.3	41.1	42.6	43.4	Gross expenditures	106	248.1	254.5	263.1	272.8
Fire	49	1.2	1.1	1.1	1.0	Less: Sales to other sectors	107	167.2	175.5	184.7	192.2
Law courts	50	9.7	10.4	10.3	10.5	Recreation and culture	108	38.1	36.9	36.1	36.1
Prisons	51	6.9	7.0	7.2	7.4	Education	109	820.0	822.4	813.4	812.8
Economic affairs	52	144.9	165.7	155.4	152.1	Elementary and secondary	110	635.7	635.6	619.9	601.1
Transportation	53	38.5	41.5	43.5	44.7	Higher	111	153.6	155.7	162.4	180.1
Highways	54	2.7	3.1	3.2	3.5	Libraries and other	112	30.8	31.1	31.0	31.6
Air	55	21.8	22.8	23.6	24.6	Libraries	113	13.2	12.8	12.6	12.7
Water	56	13.6	15.0	15.7	15.6	Other	114	17.6	18.2	18.5	18.8
Transit and railroad	57	0.4	0.6	0.9	0.9	Income security	115	76.7	75.6	75.9	76.2
Space	58	32.1	32.1	30.5	27.7	Disability	116	3.9	3.5	3.4	3.3
						Welfare and social services	117	72.8	72.1	72.5	72.9

1. Consists of consumption expenditures to administer social insurance funds, including old age and survivors insurance (social security) and railroad retirement. Excludes government employee retirement plans.

2. Consists primarily of unallocable state and local government consumption expenditures and gross investment.

Source: BEA (2014): Survey of Current Business, "Newly Available NIPA Tables." February 2014. Yellow highlights added to help identify the different relevant categories. (https://apps.bea.gov/scb/pdf/2014/02%20February/0214_newly_available_nipa_tables.pdf)

**Annex A1 - Local Government (County, Cities, Townships) Reporting:
Worksheet 28 Expenditures and Census Reporting Issues**

In Part 3 of Worksheet 28 Expenditures – County, Cities, Townships of the U.S. Census Bureau (https://www.census.gov/govs/local/get_forms.html, choose ‘Survey Worksheets’ then ‘Worksheet F28’) there is reporting of Intergovernmental expenditures (Question 8) and Direct expenditures (current and capital) (Question 9). See below for pictures of these sections and the reporting instruments.

The reporting is according to the following categories:

Categories for reporting local government expenditures in Worksheet 28

Q8 label	Q9 label	Category Name
E	F	Parks and recreation
F	G	Solid waste management
G	H	Sewerage
H	I	Water supply system
S	U	Natural resources - Flood control, soil and water conservation, drainage, irrigation, forestry and forest fire protection, agricultural fairs, and any other activities for promotion of agriculture and conservation of natural resources

The definitions of what is included in each of these categories is important to examine in order to figure out if the category would be considered ‘pure environmental’ or if it also includes non-environmental items that should, technically, be split out.

The following excerpts from Q8 and Q9 from Worksheet 28 show the reporting from Local Governments:

8 What was the amount of intergovernmental expenditures during the fiscal year indicated in **2**?

	To Other Local Governments				To the State			
	\$Bil.	Mil.	Thou.	DoI.	\$Bil.	Mil.	Thou.	DoI.
A. Streets and highways								
B. Financial administration								
C. Central administration								
D. Fire protection								
E. Parks and recreation								
F. Solid waste management								
G. Sewerage								
H. Water supply system								
S. Natural resources - Flood control, soil and water conservation, drainage, irrigation, forestry and forest fire protection, agricultural fairs, and any other activities for promotion of agriculture and conservation of natural resources.								

PART 3 – EXPENDITURES - <i>Continued</i>											
Current Operation				Capital Outlays							
Direct expenditures for employee compensation and for supplies, materials, operating leases, and contractual services Include gross salaries and wages before deductions Exclude capital outlays and depreciation/amortization				Construction Include production, additions, replacements, or major structural alterations to buildings and other improvements				Purchase of equipment, land, and existing structures Include capital leases			
F. Parks and recreation - Playgrounds; golf courses; swimming pools; museums; marinas; community music, drama, festivals; zoos, and other cultural activities.											
\$Bil.	Mil.	Thou.	Dol.	\$Bil.	Mil.	Thou.	Dol.	\$Bil.	Mil.	Thou.	Dol.
G. Solid waste management - Street cleaning and the collection, recycling, and disposal of refuse and garbage.											
H. Sewerage - Construction, maintenance, and operation of sanitary and storm sewer systems and sewage disposal plants.											
I. Water supply system											
U. Natural resources - Flood control, soil and water conservation, drainage, irrigation, forestry and forest fire protection, agricultural fairs, and any other activities for promotion of agriculture and conservation of natural resources.											

In addition to expenditures, non-tax income from fees, sales of services, sales of licenses and sales of natural resources from public lands are reported in Q5:

5 What was the amount of revenues, other than tax and intergovernmental revenues, received by this government during the fiscal year indicated in **2**?

Include

- Revenues of all funds

Exclude

- Refunds and transfers between funds and accounts of this government

A. Utility sales revenues - Gross receipts of any water, electric, gas, or transit systems operated by this government, from utility sales and charges.

Include

- Amounts received from the sale of utility commodities and services to the Federal, State, or other local governments

	Utility Sales Revenues			
	\$Bil.	Mil.	Thou.	Dol.
1. Water supply system.....				
2. Electric power system.....				
3. Gas supply system.....				
4. Transit or bus system.....				

B. Other sales and service revenues - Gross receipts from fees, sales, rentals, tolls, maintenance assessments, and other charges for commodities or services.

Exclude

- Utility receipts (*should be reported in item A.*)
- Amounts received from other governments (*should be reported in 6*)

	Other Revenues			
	\$Bil.	Mil.	Thou.	Dol.
1. Sewerage charges.....				
2. Refuse collection, disposal, and recycling charges.....				
3. Parks and recreation charges (e.g., swimming, golf, auditoriums, etc.).....				

12. Natural resources charges - Sale of minerals and other natural products from public lands and revenue from agricultural fairs and shows.....

From the U.S. Census Bureau's website for Federal, State and Local Governments Definitions, the following information about these categories can be found:

Table A2. Federal, State and Local Governments Definitions (<https://www.census.gov/govs/definitions/>)

Natural resources – Conservation, promotion, and development of natural resources, such as soil, water, forests, minerals, and wildlife. Includes irrigation, drainage, flood control, forestry and fire protection, soil reclamation, soil and water conservation, fish and game programs, and agricultural fairs.

Parks and recreation – Provision and support of recreational and cultural-scientific facilities and activities including golf courses, play fields, playgrounds, public beaches, swimming pools, tennis courts, parks, auditoriums, stadiums, auto camps, recreation piers, marinas, botanical gardens, galleries, museums, and zoos. Also includes building and operation of convention centers and exhibition halls.

Sewerage – Provision of sanitary and storm sewers and sewage disposal facilities and services, and payments to other governments for such purposes.

Solid waste management – Street cleaning, solid waste collection and disposal, and provision of sanitary landfills.

Water supply – Operation and maintenance of water supply system including acquisition and distribution of water to the general public or to other local governments for domestic or industrial use. Acquisition and distribution of water for irrigation of agricultural lands are classified under Natural resources. See Utility.

Utility – A government owned and operated water supply, electric light and power, gas supply, or transit system. Government revenue, expenditure, and debt relating to utility facilities leased to other governments or persons, and other commercial type activities of governments, such as port facilities, airports, housing projects, radio stations, steam plants, ferries, abattoirs, etc., are classified as general government activities. Also see Transit subsidies.

Health – Outpatient health services, other than hospital care, including: public health administration; research and education; categorical health programs; treatment and immunization clinics; nursing; *environmental health activities such as air and water pollution control*; ambulance service if provided separately from fire protection services, and other general public health activities such as mosquito abatement. School health services provided by health agencies (rather than school agencies) are included here. Sewage treatment operations are classified under Sewerage.

Each of these categories will now be discussed in light of the definitions for environmental protection expenditures and resource management from the SEEA-CF 2012 (UN 2014).

- The Natural resources category includes many the expenditures related to resource management (RM) – however it also includes the following non-RM expenditures: (1) irrigation and (2) agricultural fairs. The expenditures for flood control may also be a borderline case.
- The Parks and recreation category may not encompass environmental protection activities or resource management, although COFOG 05.04 includes these expenditures.
- The Sewerage category would be considered an environmental protection activity and classified as CEA EP-2.
- The solid waste management category would be considered an environmental protection activity. The only part that is a borderline activity is ‘street cleaning’ but if this activity is done to help reduce air pollution – particulates – (e.g., in the winter especially) then this is considered an EP expenditure. This category would be classified as CEA EP-3.
- The Water supply category would be considered a resource management category and is classified as CEA RM-10.

- The category “utility” is not used in the reporting from state and local governments but is an aggregation found in some statistics. The only portion of this category that is relevant is the water supply portion. All other items included are not defined as EP or RM. Typically this category will be dominated by the public transit – since these expenses are typically very large and would dominate the figures reported under this category.
- The Health category is similar with only a very minor component, in this case “air and water pollution control,” within a much larger category.
- The category “natural resources” includes a number of CReMA categories which means that these expenditures could not be easily separated from the figures reported. These include CEA RM-11 Management of forest resources, CEA RM-12 Management of wild flora and fauna, CEA RM-14 Management of minerals and CEA RM-10 Management of water.
- It should also be noted that the expenditures for the supply of drinking water are reported separately from the expenditures for the management of water resources which are part of the mixed natural resources category.

Table A3 below shows the environmentally related expenditures have been separated from, for example, the 2018 Census summary tables for state and local government finances, which show the figures that have been grossed up from the sample survey of state and local government finances by level of government and functions. Here we can find some data that separates the state and local level expenditures for water, wastewater, and waste, but only has the aggregated category for “natural resources.”

Table A3. State and Local Government Direct Expenditures by Function and by Level of Government, 2018 (Billions USD) – Excerpts from original table by environmentally relevant lines

Table Line No.	Description	United States Total		
		State & local government amount	State government amount	Local government amount
-	Environmental Expenditures Total	186.29	24.56	161.73
97	Natural resources	32.28	21.76	10.52
102	Sewerage	58.77	1.32	57.45
104	Solid waste management	26.04	1.15	24.89
115	Water supply	69.19	0.33	68.87

Source: <https://www2.census.gov/programs-surveys/gov-finances/tables/2018/18slsstab1a.xlsx>

Table A3 shows that local governments typically provide services covering waste collection and treatment, wastewater/sewerage treatment, and drinking water, the state level governments provide more resource management services and pollution control functions.

Annex A2
**Classifications for the environment: Classification of Environmental Activities (CEA),
CEPA and CReMA**

The Classification of Environmental Activities (CEA) is a functional classification that is used to classify environmental activities, products, expenditures and other transactions. It covers both environmental protection and resource management. It is based on the combination of the Classification of Environmental Protection Expenditure (CEPA) and the European proposal for resource management, called CReMA, Classification of Resource Management Activities. Since SEEA-CF was published, CReMA has been refined and the numbering changed slightly in the European system (Eurostat EGSS 2016, Annex 5).

CEPA

- 1 Protection of ambient air and climate
- 2 Wastewater management
- 3 Waste management
- 4 Protection and remediation of soil, groundwater and surface water
- 5 Noise and vibration abatement (excluding workplace protection)
- 6 Protection of biodiversity and landscapes
- 7 Protection against radiation (excluding external safety)
- 8 Research and development for environmental protection
- 9 Other environmental protection activities

Revised CReMA – Eurostat version from EGSS and regulation

- 10 Management of water
- 11 Management of forest resources
 - 11A Management of forest areas
 - 11B Minimization of the intake of forest resources
- 12 Management of wild flora and fauna
- 13 Management of energy resources
 - 13A Production of energy from Renewable sources
 - 13B Heat/energy saving and management
 - 13C Minimization of the intake of fossil energy resources as raw material
- 14 Management of minerals
- 15 Research and development activities for resource management
- 16 Other resource management activities

Once an expenditure is evaluated as having a primary purpose of environmental protection or resource management, then the CEPA/CReMA classification is used to further specify for which type of environmental domain the expenditure is relevant.