Social Performance Analysis 1

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[**Appendix C. Examples**, can be found in the sibling reference, Social Performance Analysis 2.

Appendix D. Definitions, includes informal definitions for the terms used in this reference.]

A. Introduction to Social Performance Analysis (2*)

Many corporations are concerned about their reputation as being good environmental stewards and socially sound community members. They don't want reputations for polluting rivers, gobbling up energy supplies, exploiting factory workers, wasting garbage, or producing products that fatten children. Traditionally, this derives from hardheaded concerns about being fined for violating environmental and safety regulations, being sued for harming consumers, and losing market share by being cast in the wrong limelight. Increasingly though, this derives from their investors' preference for these corporate characteristics, their employees' desire to work for firms who share these concerns, their customers' demand for goods and services produced using socially sound methods, and their growing awareness of the power of modern IT to effectively identify and deal with both "good and bad actors".

Government's role in enforcing corporate social responsibility is being replaced by investor, employee, customer, and informed citizen, demand for private sector social soundness (**3***). This reference's goal is to assist corporations to prove the social soundness of their corporate behavior in order to satisfy investor, customer, and community, demand for transparent proof of corporate social accountability. And to keep their executives, products, goods, and services, on good actor lists and off of bad actor lists.

This reference also recognizes that citizens have the same concerns about the social soundness of the public entities responsible for managing public resources. Many have firsthand experience with public entities who are unable or unwilling to effectively manage public goods. Without effective public sector leadership and management, private sector social soundness may not matter.

This reference introduces Social Performance Measures that can be used by firms and public entities to collect, measure, analyze, and explain the evidence, or materiality, that proves their public claims about conserving scarce resources. The following statement defines how firms, public entities, investors, customers, and informed citizens, use these measures.

> *Firms and public entities use Social Performance Measures that follow a Resource Conservation Value Accounting (RCA) Framework as background evidence, or materiality, to support financial reporting claims about conserving scarce resources. Their goal is to actively contribute to balanced lives and a balanced planet. Investors, customers, and informed citizens use Social Performance Measures to take concrete action to support good actors and to chasten bad actors.*

B. Social Performance Measures in Resource Conservation Accounting

The Performance Analysis 1 reference introduced Performance Measures, such as Net Savings or Net Benefits, that firms and public entities have traditionally used to measure their standard financial and economic productivity and performance. This reference extends those traditional measures with Social Performance Measures. These new measures provide quantitative and qualitative metrics that firms and public entities can use to measure their impacts on their community's public goods. These public goods comprise a community's stocks of human capital, physical capital, economic capital, natural resources capital, social capital, cultural capital, and institutional capital. These metrics provide evidence of social productivity and performance, or social soundness.

Recent newspaper reports (NYT, Smith, 2016) confirm growing investor use of Social Performance Measures, with statements such as "Investing based on E.S.G. [Environmental, Social, and Corporate Governance] factors has mushroomed in recent years, driven, in part, by big pension funds and European money managers that are trying new ways to evaluate potential investments. The idea has changed over the last three decades from managers' simple exclusion from their portfolios of 'sin stocks' such as tobacco, alcohol and firearm makers, to incorporation of E.S.G. analysis into their stock and bond picks". They cite E.S.G. investment funds, offered by companies such as Vanguard and Parnassus, which have outperformed the market.

Just as the discipline of Economics is broadly concerned about allocating scarce resources well, Social Performance Measures are broadly used to explain the evidence that proves a firm or public entity's claims about the conservation of scarce resources. For that reason, this reference avoids using terms usually associated with financial accounting such as "socially responsible reporting", "sustainability reporting", or "integrated reporting". Those terms narrowly focus on the corporate Financial Accounting surface, rather than the underlying Resource Conservation Accounting depth. And whether justified or not, the common acceptance of the phrase "cooking the books" casts doubts about the terms' true credibility.

Unlike Financial Accounting, where teams of accountants sift through extremely private data in order to publicly report upon corporate financial performance, Resource Conservation Accounting uses social networks and clubs to gather and report on forensic data made available

by firms, public entities, and others (i.e. financial reports, informed citizens, whistle-blowers, drones, big data) to confirm claims made about how they impact the services generated by public goods. Rather than financial accountants, resource conservationists collect and maintain this evidence. Although the conservationists can be employed directly by firms and public entities, scientific integrity is enhanced when the conservationists work for third-party, objective, scientific, non-governmental organizations (**4***). These conservationists are also supported in their independent action to deal with bad actors who sully the reputations of their neighbors (**5***).

Appendix A. Resource Conservation Value Accounting Framework, introduces a resource conservation accounting framework for measuring social performance. Resource conservationists use Conservation Technology Assessments (CTAs) to apply this framework and report on their social performance. A critical need addressed by CTAs is to measure the risk and uncertainty associated with balancing a company's internal need for profits, return on investment, and shareholder value, with their community's need for clean water, fresh air, stable climates, civic rights, non-rigged courts, healthy lifestyles, and spiritual meaning. CTAs do so by helping firms to identify win-win tradeoffs, benefitting both themselves and their community, which they may not have recognized from doing business as usual. At a broader scale, CTAs help investors to understand socially sound capital-allocation decisions. From a governance perspective, CTAs assist public entities to increase public returns from public goods.

C. Standards for Corporate and Public Sector Financial Accounting

The following image (KPMG, 2016) confirms that mandatory and voluntary "sustainability reporting instruments" are becoming increasingly adopted by companies throughout the world. These standards assist companies to report their accomplishments in areas such as environmental stewardship, respect for human rights, and support for their community's well-being. They align with the global "Sustainability Development Goals" adopted by international aid agencies (KPMG, 2016, UNSD, 2016).

Executive Summary – Key findings

Trends in sustainability reporting instruments

		2006		2010		2013		2016	
Reporting Instruments	Mandatory	35	58%	94	62%	130	72%	248	65%
	Voluntary	25	42%	57	38%	50	28%	135	35%
	Total	**60**		**151**		**180**		**383**	
Countries & Regions		**19**		**32**		**44**		**71** (64 with instruments)	

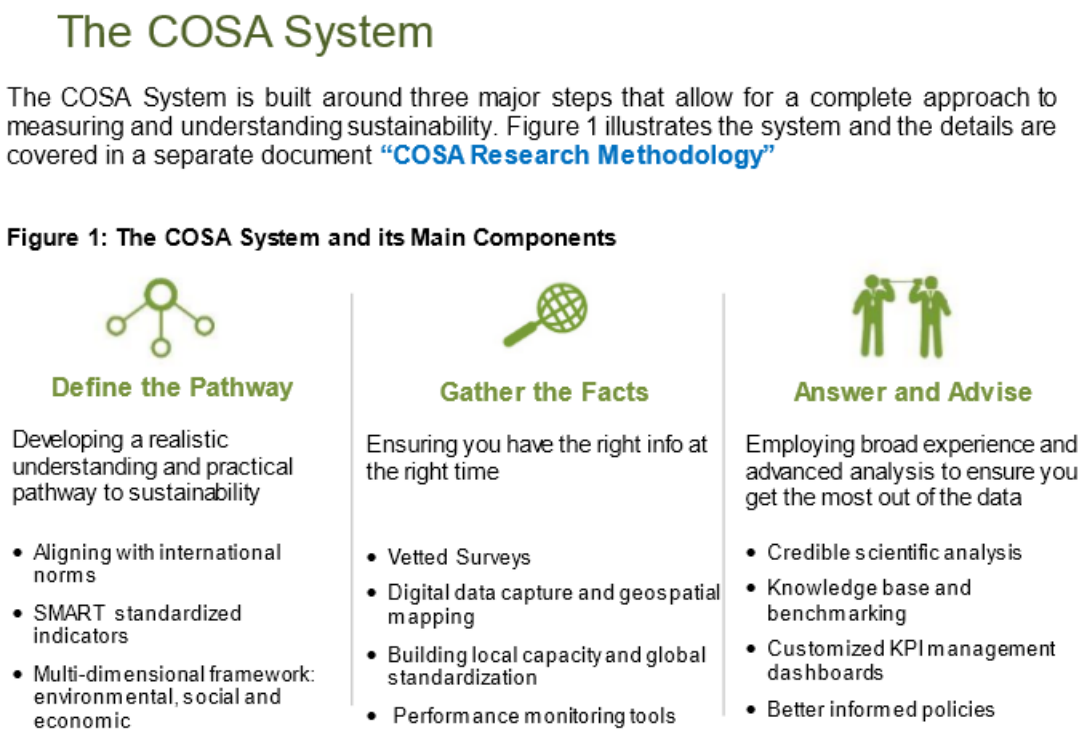
The following groups have developed these types of formal financial reporting standards to assist company and public agency efforts to report on their "sustainability" accomplishments. Note carefully the trend in mandatory, rather than voluntary, reporting instruments shown in this image. Many standards are being developed beyond the systems introduced below (i.e. refer to Appendix A and B). Although most of these systems are designed for private sector companies, many of their ingredients, such as quantitative proof of GHG reductions, can be adapted to assist public sector reporting requirements as well.

International Organizations. Corporate guidelines for reporting standards for human capital development, including human rights protection, can be found in publications put out by international organizations such as the UN Guiding Principles (UN, 2015), , and the OECD Guidelines for MNEs (OECDa, 2008). Government guidelines for the statistical reporting of economic and environmental standards can be found in publications such as the UN System of Environmental-Economic Accounting (UN, 2014) and System of Environmental-Economic Accounting 2012 Experimental Ecosystem Accounting (UN, 2014).

The United Nations Forum on Sustainability Standards (2016) has developed guidelines and applied knowledge platforms for using "Voluntary Sustainability Standards" (VSS) to support industry-specific efforts to certify the social soundness of their products. Their current efforts (UNFSS, 2016) attempt to integrate the role of the public sector, or more specifically to answer the question: "What are the optimal dynamics between public policy processes and voluntary

sustainability standards to ensure sustainability objectives are most effectively met?”. Their motivation derives from credible evidence proving that both public and private sector acceptance and cooperation are needed to achieve fully successful voluntary standard systems.

The following image (Committee on Sustainability Assessment (COSA), 2014) confirms that international organizations are actively publishing guidelines, developing standards, and building tools, to “measure and understand sustainability”. That organization’s methods are based on multidimensional systems of Indicators grounded in Economic, Environmental, and Social, “global themes”.



Appendix 1 in the KPMG, 2016 reference and Appendix 3 in the TFCRFD, 2016 reference identify additional international efforts in this area. The following images (UN, 2015 and TFCRFD 2016) are representative of some of these efforts.

REPORTING FRAMEWORK

PART A: GOVERNANCE OF RESPECT FOR HUMAN RIGHTS

POLICY COMMITMENT

A1 **What does the company say publicly about its commitment to respect human rights?**

- **A1.1** How has the public commitment been developed?
- **A1.2** Whose human rights does the public commitment address?
- **A1.3** How is the public commitment disseminated?

EMBEDDING RESPECT FOR HUMAN RIGHTS

A2 **How does the company demonstrate the importance it attaches to the implementation of its human rights commitment?**

- **A2.1** How is day-to-day responsibility for human rights performance organized within the company, and why?
- **A2.2** What kinds of human rights issues are discussed by senior management and by the Board, and why?
- **A2.3** How are employees and contract workers made aware of the ways in which respect for human rights should inform their decisions and actions?
- **A2.4** How does the company make clear in its business relationships the importance it places on respect for human rights?
- **A2.5** What lessons has the company learned during the reporting period about achieving respect for human rights, and what has changed as a result?

PART B: DEFINING THE FOCUS OF REPORTING

B1 **Statement of salient issues:** State the salient human rights issues associated with the company's activities and business relationships during the reporting period.

B2 **Determination of salient issues:** Describe how the salient human rights issues were determined, including any input from stakeholders.

B3 **Choice of focal geographies:** If reporting on the salient human rights issues focuses on particular geographies, explain how that choice was made.

B4 **Additional severe impacts:** Identify any severe impacts on human rights that occurred or were still being addressed during the reporting period, but which fall outside of the salient human rights issues, and explain how they have been addressed.

PART C: MANAGEMENT OF SALIENT HUMAN RIGHTS ISSUES

SPECIFIC POLICIES

C1 **Does the company have any specific policies that address its salient human rights issues and, if so, what are they?**

- **C1.1** How does the company make clear the relevance and significance of such policies to those who need to implement them?

Table A3.1
Select Disclosure Frameworks, Governments

Region: Framework	Target Reporter	Target Audience	Mandatory or Voluntary	Materiality Standard	Types of Information Disclosed	Disclosure Location	External Assurance Required
Australia: National Greenhouse and Energy Reporting Act (2007)	Financial and nonfinancial firms that meet emissions or energy production or consumption thresholds	General public	Mandatory if thresholds are met	Based on emissions above a certain threshold	GHG emissions, energy consumption, and energy production	Report to government	Regulator may, by written notice to corporation, require an audit of its disclosures
European Union (EU): EU Directive 2014/95 regarding disclosure of nonfinancial and diversity information (2014)	Financial and nonfinancial firms that meet size criteria (i.e., have more than 500 employees)	Investors, consumers, and other stakeholders	Mandatory; must be effective in Member States by December 6, 2016	None specified	Land use, water use, greenhouse gas (GHG) emissions, use of materials, and energy use	Corporate financial report or separate report (published with financial report or on website six months after the balance sheet date and referenced in financial report)	Member States must require that statutory auditor checks whether the nonfinancial statement has been provided. Member States may require independent assurance for information in nonfinancial statement
France: Article 173, Energy Transition Law (2015)	Listed financial and nonfinancial firms Additional requirements for institutional investors	Investors, general public	Mandatory	None specified	Consequences on climate change of the company's activities and of the use of goods and services it produces. Institutional investors: GHG emissions, contribution to goal of limiting global warming	Annual report	Mandatory review on the consistency of the disclosure by an independent third party, such as a statutory auditor.
India: National Voluntary Guidelines on Social, Environmental, and Economic Responsibilities of Business (2011)	Financial and nonfinancial firms	Investors, general public	Voluntary	None specified	Materials, energy consumption, water, discharge of effluents, GHG emissions, and biodiversity	Not specified; companies may furnish a report or letter from owner/chief executive officer	Guidelines include third-party assurance as a "leadership indicator" of company's progress in implementing the principles

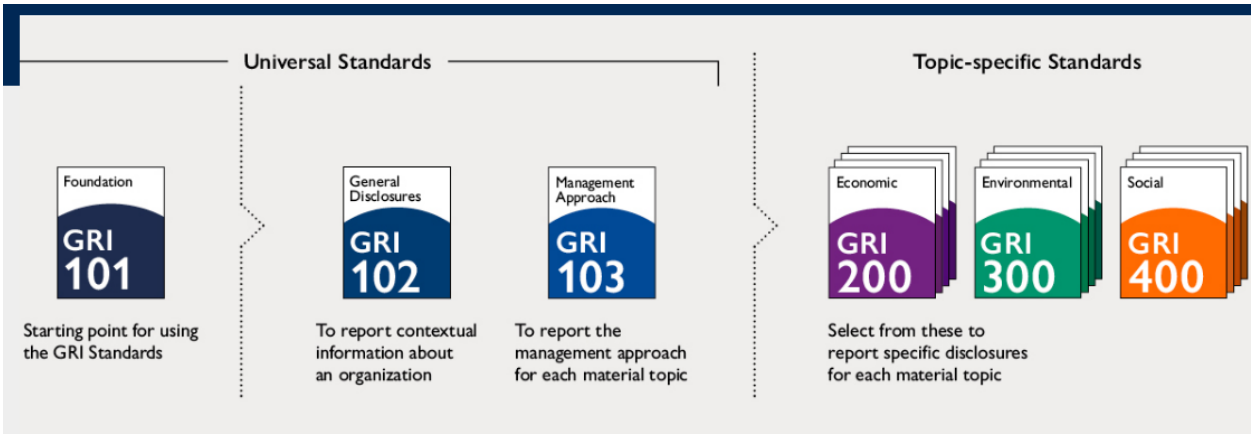
International Accounting Standards Board (IASB) and US Financial Accounting Standards Board (FASB). International and national "keepers" of corporate financial reporting standards and recommendations. The following images derive from some of their publications and presentations.

International Integrated Reporting Council (IIRC). "A global coalition of regulators, investors, companies, standard setters, the accounting profession and NGOs. The coalition is promoting communication about value creation as the next step in the evolution of corporate reporting". The following image derives from some of their publications and presentations.

<IR> and the reporting landscape

<IR> is the central strand of a global movement towards establishing a more inclusive economic system and a sustainable capital markets system, facilitated and encouraged by a more effective corporate reporting system. The progress towards global adoption of <IR> has seen milestones achieved by many organizations.

Global Sustainability Standards Board (GSSB) and Global Reporting Initiative (GRI). Their stated objective is "to make sustainability reporting standard practice by providing guidance and support to organizations". "GRI Standards are the first global standards for sustainability reporting". The following image derives from some of their publications and presentations.



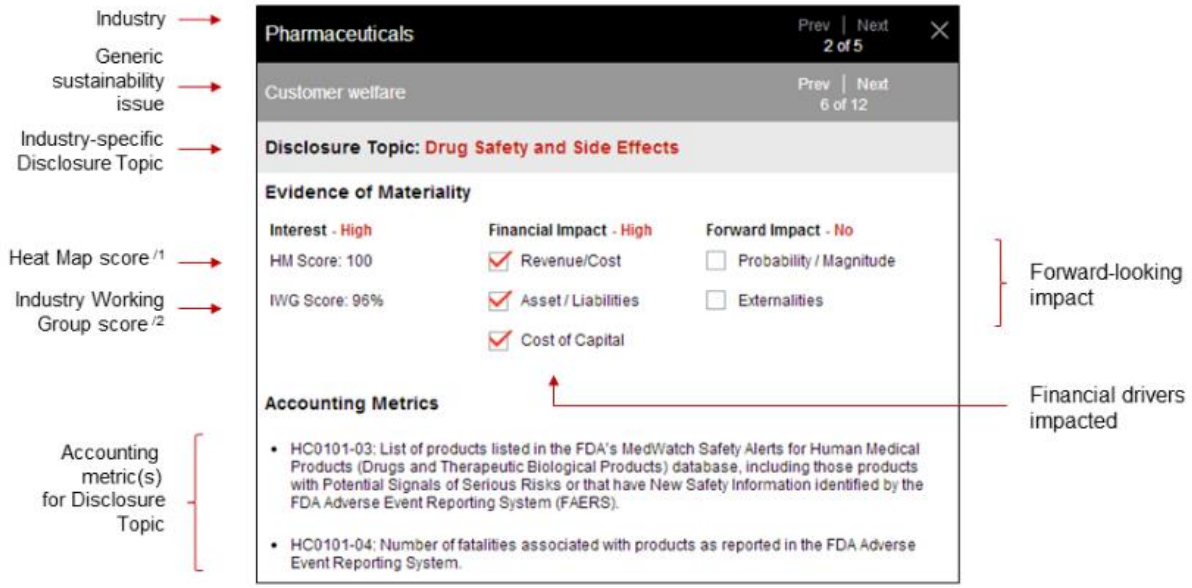
The GRI Standards represent global best practice for reporting publicly on a range of economic, environmental and social impacts. Sustainability reporting based on the Standards provides information about an organization's positive or negative contributions to sustainable development.

The modular, interrelated GRI Standards are designed primarily to be used as a set, to prepare a sustainability report focused on material topics. The three universal Standards are used by every organization that prepares a sustainability report. An organization also chooses from the topic-specific Standards to report on its material topics – economic, environmental or social.

Preparing a report in accordance with the GRI Standards provides an inclusive picture of an organization's material topics, their related

Sustainability Accounting Standards Board (SASB)**.** "The mission of SASB is to develop and disseminate sustainability accounting standards that help public corporations disclose material, decision-useful information to investors. That mission is accomplished through a rigorous process that includes evidence-based research and broad, balanced stakeholder participation." The following image derives from some of their publications and presentations.

Information available in pop-up window

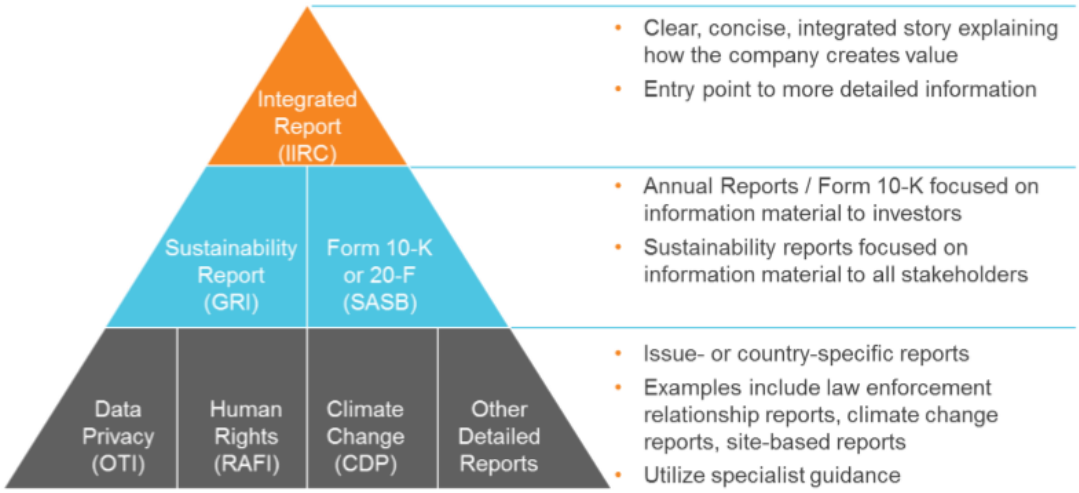


/1 **HM Score: A** score out of 100 indicating the relative importance of the issue among SASB's initial list of 43 generic sustainability issues. The score is based on the frequency of relevant keywords in documents (i.e., SEC filings, shareholder resolutions, legal news, key newswires, and CSR reports) that are available on the Bloomberg terminal for the industry's publicly listed companies.
/2 **IWG Score:** The percentage of IWG participants that found the issue to be material. (-) denotes that the issue was added after the IWG was convened.

Domain-Specific Reporting

The bottom segment of the triangle depicted in the following image (Allison-Hope, 2016) demonstrates the types of domain-specific reports that corporations use to provide detailed proof of their impacts on specific "capitals" (i.e. simplistically, data privacy = social capital, human rights = human capital, climate change = natural resources capital).

BSR | A Proposal for the Future of Sustainability Reporting 10



At the top of the triangle there is huge value in a clear, concise, and integrated story that explains how the company creates value for both shareholders and society at large. This offers an entry point to more detailed information available elsewhere and is where the IIRC Integrated Reporting Framework can be used.

The following images confirm that international organizations, such as the Task Force on Climate Related Financial Disclosures (2016), are currently developing strong recommendations, guidelines, and principles, in specific domain fields, such as climate change, that help firms to understand and disclose financial risks better.

The Task Force structured its recommendations around four thematic areas that represent core elements of how organizations operate—governance, strategy, risk management, and metrics and targets. The four overarching recommendations are supported by key climate-related financial disclosures—referred to as recommended disclosures—that build out the framework with information that will help investors and others understand how reporting organizations think about and assess climate-related risks and opportunities. In addition, there is guidance to support all organizations in developing climate-related financial disclosures consistent with the recommendations and recommended disclosures as well as *supplemental* guidance for specific sectors. The structure is depicted in Figure 2 below.

Figure 2

Recommendations and Guidance

Recommendations
Four widely adoptable recommendations tied to: governance, strategy, risk management, and metrics and targets

Recommended Disclosures
Specific recommended disclosures organizations should include in their financial filings to provide decision-useful information

Guidance for All Sectors
Guidance providing context and suggestions for implementing the recommended disclosures for all organizations

Supplemental Guidance for Certain Sectors
Guidance that highlights important considerations for certain sectors and provides a fuller picture of potential climate-related financial impacts in those sectors

Supplemental guidance is provided for the financial sector and for non-financial sectors potentially most affected by climate change

To underpin its recommendations and help guide current and future developments in climate-related financial reporting, the Task Force developed seven principles for effective disclosure (Figure 4), which are described more fully in Appendix 6. When used by organizations in preparing their climate-related financial disclosures, these principles can help achieve high-quality and decision-useful disclosures that enable users to understand the impact of climate change on organizations. The Task Force encourages organizations adopting its recommendations to consider these principles as they develop climate-related financial disclosures.

The Task Force's disclosure principles are largely consistent with internationally accepted frameworks for financial reporting and are generally applicable to most providers of financial disclosures. The principles, taken together, are designed to assist organizations in making clear the linkages and connections between climate-related issues and their governance, strategy, risk management, and metrics and targets

Figure 4

Principles for Effective Disclosures

1. Disclosures should represent relevant information
2. Disclosures should be specific and complete
3. Disclosures should be clear, balanced, and understandable
4. Disclosures should be consistent over time
5. Disclosures should be comparable among companies within a sector, industry, or portfolio
6. Disclosures should be reliable, verifiable, and objective
7. Disclosures should be provided on a timely basis

The principals outlined for reporting climate change-related financial risks in the previous image are the same principals used for any science-based report. The following image (USEPA, 2000) confirms that science-oriented organizations concur with using these principles in science-based reports that must characterize risk and uncertainty.

1.4 Overview Presentation of TCCR Principles

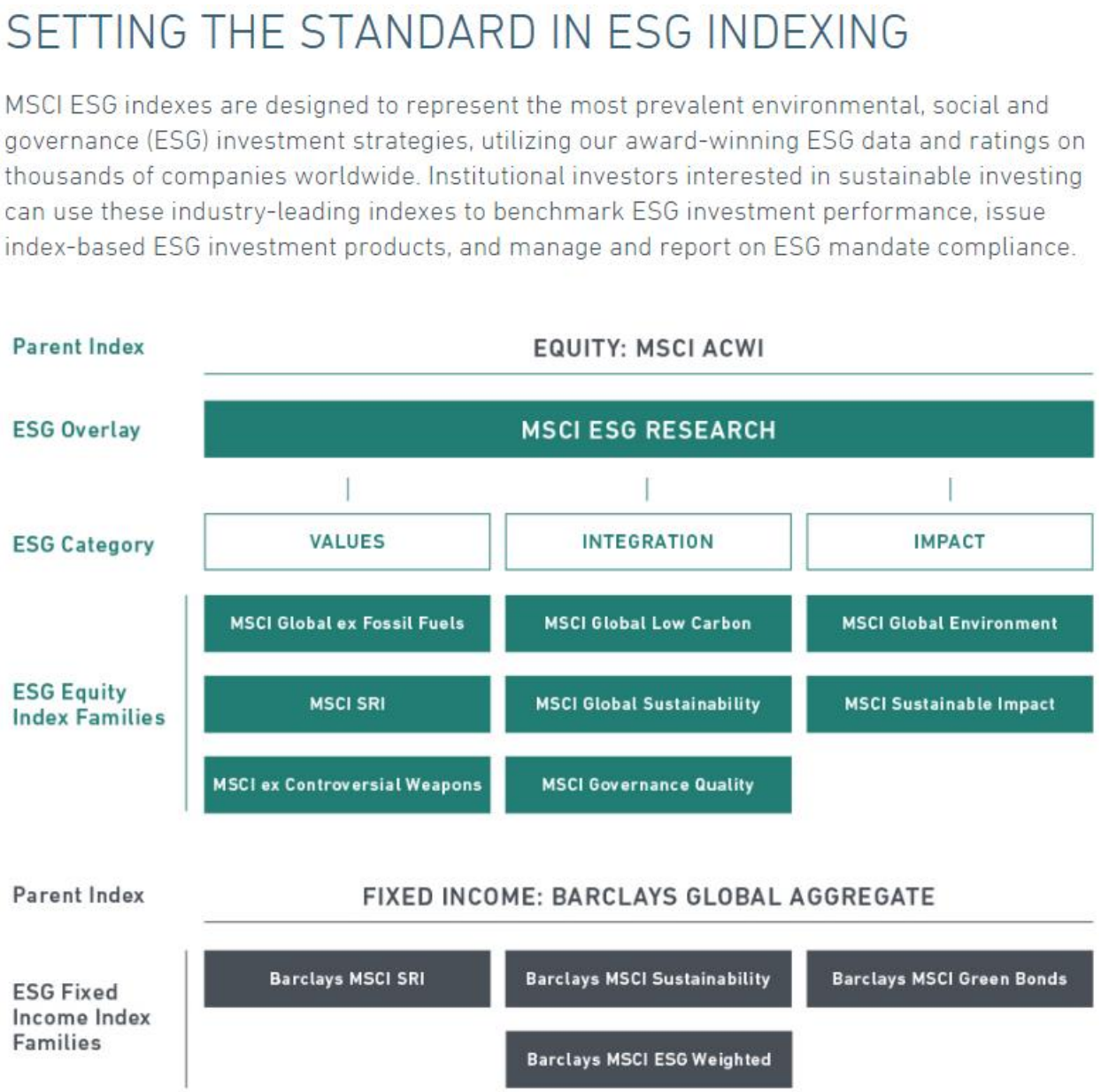
The following table presents an encapsulated overarching presentation of the TCCR principles and their criteria for a good risk characterization. It is meant to serve as a stand alone summary one-page guide for the use of TCCR throughout the risk assessment process.

Principle	Definition	Criteria for a Good Risk Characterization
Transparency	Explicitness in the risk assessment process.	✓ Describe assessment approach, assumptions, extrapolations and use of models ✓ Describe plausible alternative assumptions ✓ Identify data gaps ✓ Distinguish science from policy ✓ Describe uncertainty ✓ Describe relative strength of assessment
Clarity	The assessment itself is free from obscure language and is easy to understand.	✓ Employ brevity ✓ Use plain English ✓ Avoid technical terms ✓ Use simple tables, graphics, and equations
Consistency	The conclusions of the risk assessment are characterized in harmony with other EPA actions.	✓ Follow statutes ✓ Follow Agency guidance ✓ Use Agency information systems ✓ Place assessment in context with similar risks ✓ Define level of effort ✓ Use review by peers
Reasonableness	The risk assessment is based on sound judgment.	✓ Use review by peers ✓ Use best available scientific information ✓ Use good judgment ✓ Use plausible alternatives

Investment Rating and Investment Companies

The following image (MSCI, 2016) demonstrates tools currently being used by investors that employ Environmental, Social, and Corporate Governance (E.S.G) factors, or Social Performance Measures, in their investment advice and for their social impact investment funds. That company cites research carried out by Barclays “that found investment-grade bonds with higher ESG scores outperformed those with low ESG scores between 2007 and 2015”. Smith (NYT, 2016) cites the growing use of similar investment tools offered by TIAA-CREFF, Vanguard, Goldman Sachs, FTSE Russell, S&P Dow Jones, and Sustainalytics.

In a similar way, The Economist (2017) highlights how social impact investments in companies that offer "measurable social or environmental benefits as well as [profits]" are becoming mainstream, with investment companies such as BlackRock, TIAA, PCCM, Goldman Sachs, Bain Capital, and Zurich, actively increasing their portfolios. In recent years, several U.S. states (i.e. Oregon, California, and Colorado) have allowed corporations to register for "public benefit", rather than "internal profit only", purposes.



International Public Sector Accounting Standards Board (IASB). International "keepers" of public sector financial reporting standards and recommendations. The following image (IFAC, 2011) explains the role of this board.

IPSASB INTERNATIONAL PUBLIC SECTOR ACCOUNTING STANDARDS BOARD

2011

What is the IPSASB?

The IPSASB is an independent standard-setting board that develops high-quality International Public Sector Accounting Standards (IPSASs), guidance, and resources for use by public sector entities around the world for general purpose financial reporting. The IPSASB is one of four independent standard-setting boards that are supported by the International Federation of Accountants (IFAC), the worldwide organization for the accountancy profession.

What Are The IPSASB's Goals And Objectives?

The IPSASB aims to enhance the quality and transparency of public sector financial reporting by:

- Establishing high-quality accounting standards for use by public sector entities;
- Promoting the adoption, and international convergence to, IPSASs;
- Providing comprehensive information for public sector financial management and decision making; and
- Providing guidance on issues and experiences in financial reporting in the public sector.

Why Are IPSASs Important?

The financial and sovereign debt crises have brought to light, as never before, the need for better financial reporting by governments worldwide, and the need for improvements in the management of public sector resources. Citizens are affected by a government's financial management decisions. Strong and transparent financial reporting has the potential to improve public sector decision making and make governments more accountable to their constituents. The failure of governments to manage their finances has in the past, and could again in the future, have dramatic consequences such as loss of democratic control, social unrest, and the failure of governments to meet their commitments today and in the future.

Public Sector Laws and Regulations. A large number of laws and regulations govern the reporting standards required by public sector entities. For example, in the U.S., the "National Environmental Policy Act of 1969 (NEPA) requires Federal agencies to consider and disclose to the public the environmental effects of a proposed Federal action and alternatives before making a decision or taking action" (USDOI, 2015). Similar requirements, affecting both private and public entities, exist in the form of Environmental Impact Statements, Environmental Assessments, Food and Drug Safety Standards, and Health Technology Assessments.

D. Standards, or Work Breakdown Structures, for Resource Conservation Accounting

The Work Breakdown Structures tutorial explains the standards used in DevTreks for resource conservation accounting. Rather than the previous section's emphasis on the standards being used only for corporate and public sector financial reporting, DevTreks stresses the need for standards for any cost, benefit, and performance content. The standards are not only needed, and must not only be used, for annual financial reporting (**6***). They must be used to increase the accountability of any project, program, technology assessment, or financial report, which is concerned with presenting scientific evidence of resource conservation.

The following image, from the WBS reference, demonstrates a prototype WBS developed by the author several decades ago for general conservation planning. It also includes a classification system for natural resources capital accounting and can be downloaded from the WBS tutorial. The natural resources capital elements correspond to "Conservation Practice Standards" that are defined more thoroughly for each U.S. state in separate publications (and may be found online by searching through the publications of USDA, Natural Resources Conservation Service state offices).

The Antonopoulos et al. reference (2016) demonstrates how agricultural conservation practice standards have been developed and codified for Europe. The Sustainable Food Lab (2016) reference includes a WBS that represents a "customizable framework of indicators for measuring farm-level sustainability in smallholder agricultural supply chains".

6.1	Institutional Capital		
	6.1.1	Institutional Capital, General	
	6.1.2	Laws and Policies, General	
	6.1.3	Farmland Preservation Laws	
	6.1.4	Natural Resource Conservation Laws	
6.2	Human Capital		
	6.2.1	Human Capital, General	
	6.2.2	Education	
	6.2.2	Labor	
		6.2.2.1	n/a	Labor Availability
		6.2.2.2	n/a	Labor Training
		6.2.2.3	n/a	Employee Participation
		6.2.2.4	n/a	Performance and Incentives
6.3	Economic Capital		
	6.3.1	Economic Capital, General	
	6.3.2	Work Process	
		6.3.2.1	n/a	Outcome Index Results
		6.3.2.2	n/a	Best Practice Compliance
	6.3.3		
	6.3.4	Natural Resource Assets	
		6.3.4.1	n/a	Production Input Service Flow
		6.3.4.2	n/a	Amenity Service Flow
		6.3.4.3	n/a	Life Support Service Flow
		6.3.4.4	n/a	Residual Handling Service Flow
	6.3.5	Economic Production	
		6.3.5.1	n/a	Output Production
		6.3.5.2	n/a	Commodity Production
		6.3.5.3	n/a	Efficient Input Use
	6.3.6	Environmental Impacts	
		6.3.6.1	n/a	Risk of Negative Environmental Impacts
		6.3.6.2	n/a	Social Costs
		6.3.6.3	n/a	Damage Assessments
	6.3.7	Recreation	
		6.3.7.1	NRCS xxxx	Recreation Area Improvement
		6.3.7.2	NRCS xxxx	Recreation Land Grading and Shaping
		6.3.7.3	NRCS xxxx	Recreation Trail and Walkway
6.4	Cultural Capital		
	6.4.1	Cultural Capital, General	
	6.4.2	Historic Preservation	
		6.4.2.1	n/a	Compliance with Historic Preservation Laws
	6.4.3	Antiquities and Artifacts	
		6.4.3.1	n/a	Compliance with Antiquiries and Artifacts Laws
6.5	Social Capital		
	6.5.1	Social Capital, General	
	6.5.2	Social Networks	
	6.5.3	Information Access and Open Communication	

The following image (Bloomberg, 2014) demonstrates that existing financial accounting reporting systems share a lot in common with WBSs.

BLOOMBERG L.P. PROCESS FOR DETERMINING MATERIALITY	Save Date: 5/20/2015 1:42 PM

3. APPENDICES

3.1 Appendix 1 – SASB Materiality Matrix

	SASB			
DISCLOSURE	Internet Media & Services	Media Production & Distribution	Professional Services	COMMENTS
ENVIRONMENT				Bloomberg has completed an MD&A using SASB's guidance comprised of the Activity and Accounting Metrics for three industries to which Bloomberg's business offerings apply. The nature of SASB's reporting structure and requirements are such that only those SASB "Issues" deemed most likely to be material to the average investor for the respective industries are included in the standards. The metrics are designed to capture meaningful information about each of the issues. We have determined that each of the issues SASB has identified across the three industries
GHG emissions				
Air quality				
Energy management				
Fuel management				
Water and wastewater management				
Waste and hazardous materials management				
Biodiversity impacts				
SOCIAL CAPITAL				
Human rights and community relations				
Access and affordability				
Customer welfare				
Data security and customer privacy				
Fair disclosure and labeling				
Fair marketing and advertising				
HUMAN CAPITAL				
Labor relations				
Fair labor practices				
Employee health, safety and wellbeing				
Diversity and inclusion				
Compensation and benefits				

The following image (GSSB, 2013) reinforces the point that existing financial accounting reporting systems share a lot in common with WBSs and may serve the same purposes.

G4 SPECIFIC STANDARD DISCLOSURES OVERVIEW

DISCLOSURES ON MANAGEMENT APPROACH

G4-DMA

Indicators by Aspects

CATEGORY: ECONOMIC

Economic Performance — OECD

G4-EC1, G4-EC2, G4-EC3, G4-EC4

Market Presence

G4-EC5, G4-EC6

Indirect Economic Impacts

G4-EC7, G4-EC8

Procurement Practices

G4-EC9

CATEGORY: ENVIRONMENTAL — OECD/UNGC

Materials

G4-EN1, G4-EN2

Energy

G4-EN3, G4-EN4, G4-EN5, G4-EN6, G4-EN7

Water

G4-EN8, G4-EN9, G4-EN10

Biodiversity

G4-EN11, G4-EN12, G4-EN13, G4-EN14

Emissions

Indicators by Aspects

CATEGORY: ENVIRONMENTAL — OECD/UNGC

Products and Services

G4-EN27, G4-EN28

Compliance

G4-EN29

Transport

G4-EN30

Overall

G4-EN31

Supplier Environmental Assessment

G4-EN32, G4-EN33

Environmental Grievance Mechanisms

G4-EN34

CATEGORY: SOCIAL

LABOR PRACTICES AND DECENT WORK — OECD/UNGC

Employment

G4-LA1, G4-LA2, G4-LA3

Labor/Management Relations — UNGC

G4-LA4

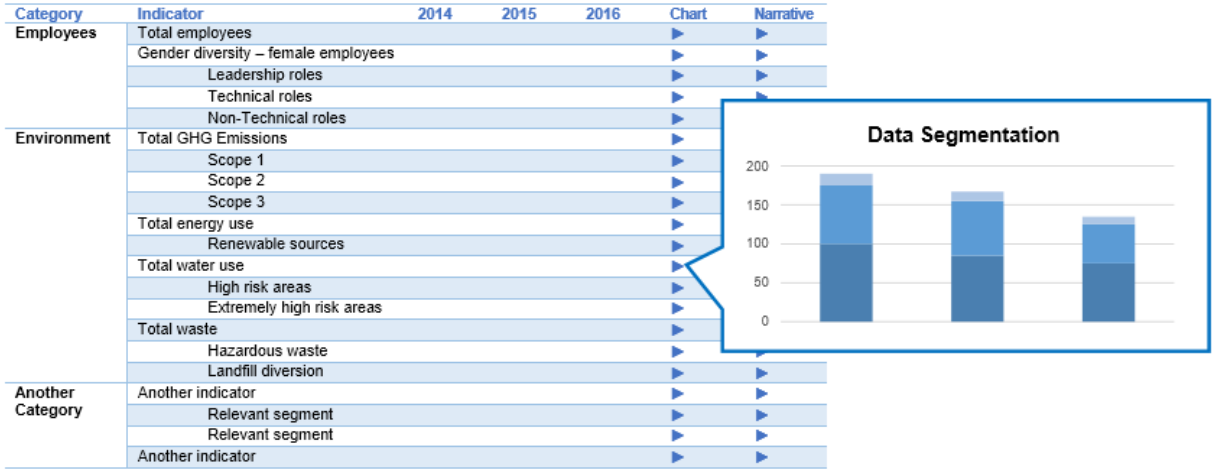
Occupational Health and Safety — OECD

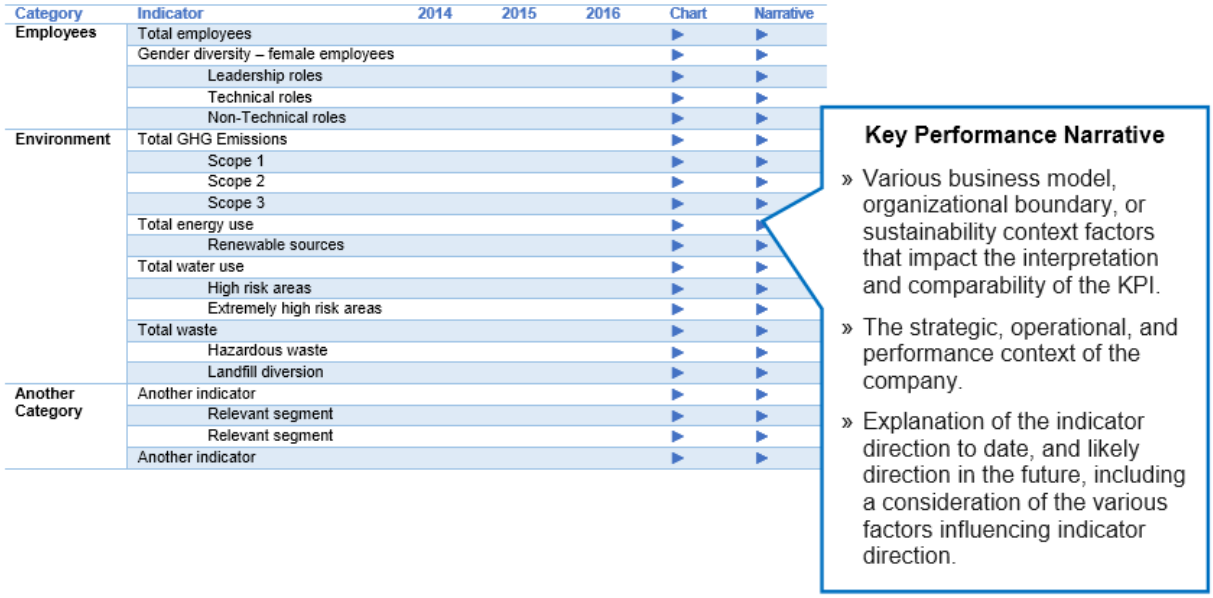
G4-LA5, G4-LA6, G4-LA7, G4-LA8

Training and Education — OECD

G4-LA9, G4-LA10, G4-LA11

The following image (Allison-Hope, 2016) demonstrates the use of Performance Indicators within a WBS for sustainability reporting. The use of indicators and WBSs are explained in the Resource Stock and Monitoring and Evaluation tutorials. These indicators correspond to the "Disclosures" displayed in previous images.





The following image (Polasky et al, 2015) highlights the major problem faced by any user of financial or resource conservation accounting standards systems, including Work Breakdown Structures. None of the ecosystem service reporting systems shown in this image has wide acceptance and multi-sectoral use. As the authors put it "One impediment to rapid mainstreaming of ecosystem services stems from the proliferation of definitions, conceptual

frameworks, approaches, datasets, and models". That statement holds true for all public services generated by all public capital stocks.

User	Use Context	Information Base: Definition of terms and approach (1)	Information Base: Methods for evaluating provision of goods and services (2)	Information Base: Methods for evaluating values (3)	General Standard Setting Entity	Ecosystem Services Standards Entity
Governments	**national income & wealth accounts**				UNSC, GA	
	land use and/or development planning				GA	GA
	environmental impact assessment				IAIA, GA	CBD
	mitigation (environmental offsets)				BBOP, CDM, GA	
	agricultural subsidies				GA, WTO	
	mining subsidies				GA, WTO	
	water pricing				GA, IBNET	
	electricity pricing				GA, CEER, ERRA	EPRI
	property tax				GA, TAF	
	(flood) disaster response				GA	TNC
	risk assessment				ISO	ICES
	fisheries management				GA, UN	ICES
	environmental-economic accounts				UN SC, GA	WAVES
	public lands management				GA	GA
	payments for ecosystem services				GA, UN-REDD	FE
Corporations	**supply chain analysis**				ISO, CSCMP	NVI
	risk assessment				ISO	NCD
	corporate accounting				IASB, GA	NCC, NCD
	corporate sustainability reporting				GRI	SASB
	life-cycle assessment				ISO, LCI	LCI
	product certification				ISO	RA

Fig. 1. Subset of use contexts for ecosystem service standards. Dark blue cells indicate that standards exist that allow for consideration of most ecosystem services in all parts of the use context. Light blue cells indicate that standards exist for some, including some ecosystem services in all parts of the use context or all services in some parts of the use context. Brown cells indicate that standards exist but almost never include ecosystem service information. Gray cells indicate that there are not widely agreed-upon standards. BBOP, Business and Biodiversity Offsets Program; CBD, Convention on Biological Diversity; CDM, Clean Development Mechanism; CEER, Council of European Energy Regulators; CSCMP, Council of Supply Chain Management Professionals; EPRI, Electric Power Research Institute. ERRA, Energy Regulators Regional Association; FE, Future Earth; GA, government agencies; GRI, Global Reporting Initiative; IAIA, International Association for Impact Assessment; IASB, International Accounting Standards Board; IBNET, International Benchmarking Network for Water and Sanitation Utilities; ICES, International Council for the Exploration of the Sea; ISO, International Organization for Standardization; LCI, Life Cycle Initiative; NCC, Natural Capital Coalition; NCD, Natural Capital Declaration; NVI, Natural Value Initiative; RA, Rainforest Alliance; SASB, Sustainability Accounting Standards Board; TAF, The Appraisal Foundation; TNC, The Nature Conservancy; UN, United Nations; UN-REDD, United Nations REDD Program; UNSC, United Nations Statistical Commission; WAVES, Wealth Accounting and the Valuation of Ecosystem Services; WTO, World Trade Organization. Modified with permission from the US Forest Service Forest to Faucet Program.

Appendix A contains a new WBS, **Public and Private Performance Risk Tradeoff WBS,** developed as a starting place for the needed resource conservation accounting standards. This new WBS has been designed to illustrate how tradeoffs between public sector-related disclosures and private company-related disclosures can be understood and reported more easily. It helps public sector entities and companies to identify, understand, report, and reduce risks, from internal threats they impose on themselves and external threats posed by external actors. Both parties can work in tandem to use their knowledge of risks and tradeoffs to advance each other's

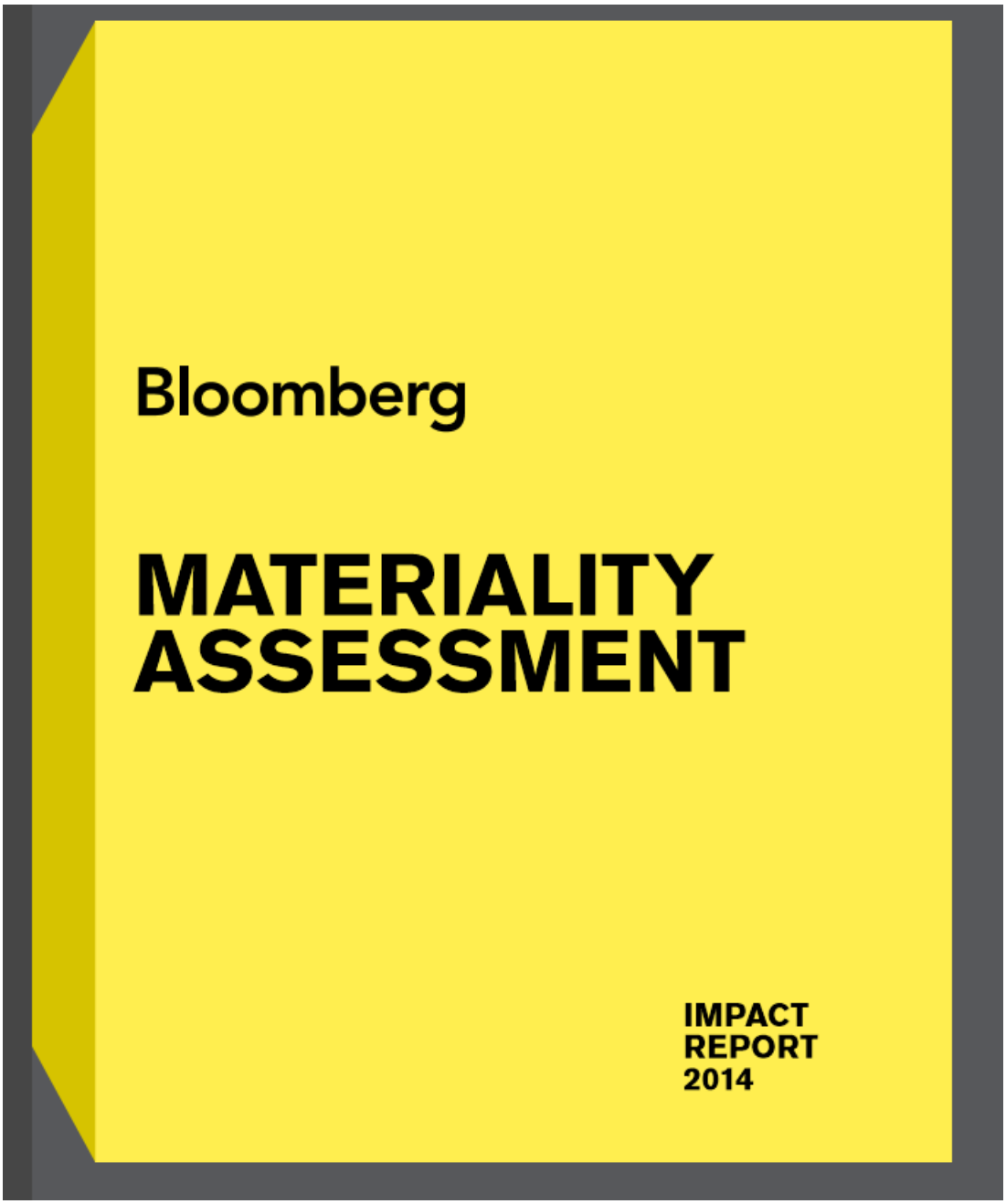
goals. For example, the UNFSS (2016) discusses how "Rather than taking individual action, governments can join forces with the private sector and civil society to amplify the sustainability benefits of VSS [Voluntary Sustainability Standards]". Appendices B and C demonstrate how the WBS can be integrated with international social and economic development goals, VSSs, and WBSs.

This WBS still accommodates Polasky's et al (2015) need for mainstream ecosystem service reporting standards, but within the larger context of protecting and improving all public services generated by all public capital stocks. Just as natural resources capital stocks generate ecosystem services, social capital stocks generate social equity services, institutional capital stocks generate political and judicial system services, cultural capital stocks generate spiritual meaning services, and physical capital stocks generate disaster resiliency services. Ecosystem services, or any other public service, can't be protected properly, or improved efficiently, without a clear understanding of their full social services context.

Although this WBS can be downloaded from the Performance Analysis tutorial, Footnote 11 discusses DevTreks' preference for using digital (rather than bricks and mortar), science-oriented, online, social networks to maintain and further develop these standards.

E. Conservation Technology Assessments (CTA) for Corporate and Public Sector Financial Reporting

Corporations, employees, investors, corporate regulators, and government auditors, want transparent, standardized, scientific, evidence that corporations and public entities are accurately reporting their progress in achieving their stated Social Performance goals. Specifically, evidence must be maintained that proves the accuracy of the numbers reported in the following types of "socially sound" financial reports (Bloomberg 2014, Microsoft 2016, and Canada 2016).


Bloomberg
MATERIALITY ASSESSMENT
IMPACT REPORT 2014

1.5 About This Report

This 2015 Microsoft Citizenship Report explains our policies, program, and performance on our material environmental, social, and governance (ESG) issue areas as well as how we address other important corporate responsibility issues. As you read this report, we welcome your unique perspective about the issues you expect to see addressed in the future. Please email your comments to **mcitizen@microsoft.com.**

Scope

Unless otherwise stated, information in this report covers all of Microsoft's global operations during our fiscal year 2015 (July 1, 2014 to June 30, 2015).

Standards

This report contains Standard Disclosures from the Global Reporting Initiative's G4 Sustainability Reporting Guidelines, which we used to prepare this report. Please see our **online GRI G4** Index for detailed data and additional information. The human rights-related disclosures are based on the UN Guiding Principles on Business and Human Rights Reporting Framework. In addition, this report serves as Microsoft's annual Communication on Progress under the United Nations (UN) Global Compact. The following table describes the location of relevant report content for each of the UN Global Compact's 10 principles.

UN Global Compact Index

Human Rights

Principle 1: Businesses should support and respect the protection of internationally proclaimed human rights; and

Principle 2: make sure they are not complicit in human rights abuses.

Labor

Principle 3: Businesses should uphold the freedom of association and the effective recognition of the right to collective bargaining;

Principle 4: the elimination of all forms of forced and compulsory labor;

Principle 5: the effective abolition of child labor; and

Principle 6: the elimination of discrimination in respect of employment and occupation.

Environment

Principle 7: Businesses should support a precautionary approach to environmental challenges;

Principle 8: undertake initiatives to promote greater environmental responsibility; and

Principle 9: encourage the development and diffusion of environmentally friendly technologies.

Anti-corruption

Principle 10: Businesses should work against corruption in all its forms, including extortion and bribery.

The following image (UN, 2014) demonstrates that ecosystem service accounting uses techniques that are very similar to the CTA techniques introduced in the Resource Stock references. Although this framework is used for government statistical reporting, the references explain that CTAs derive from the health care sector's Health Technology Assessments (HTA).

HTAs can be, and are, used to support public and private sector investing in health technologies and, by extension, performance accountability.

2.50 An asset account is structured as shown in table 2.3. It starts with the opening stock of environmental assets and ends with the closing stock of environmental assets. In physical terms, the changes between the beginning and the end of the accounting period are recorded as either additions to the stock or reductions in the stock and, wherever possible, the nature of the addition or reduction is recorded. In monetary terms, the same entries are made but an additional entry is included for the purpose of recording the revaluation of the stock of environmental assets. This entry accounts for the changes in the value of assets over an accounting period that are due to movements in the price of the assets.

Table 2.3
Basic form of an asset account

Opening stock of environmental assets
Additions to stock
Growth in stock
Discoveries of new stock
Upward reappraisals
Reclassifications
Total additions of stock
Reductions of stock
Extractions
Normal loss of stock
Catastrophic losses
Downward reappraisals
Reclassifications
Total reductions in stock
Revaluation of the stock[a]
Closing stock of environmental assets

[a] Only applicable for asset accounts in monetary terms.

The following image (Boston College, 2010) demonstrates how some corporations provide background documentation to support the environmental component of their financial reports. This image confirms that some of these Corporate Social Responsibility (CSR) reports use the same techniques, such as Life Cycle Analysis, explained in the Resource Stock Calculation and Life Cycle tutorials.

The following image comes from the fundamental concepts section of the Integrated Reporting Framework (IIRC, 2013). These concepts are very similar to the CTA concepts introduced in the Technology Assessment tutorials (i.e. the stock of capitals and the flow of services used in the definition for CTA; the goal of contributing to balanced resource stocks). The six "capitals" addressed in this reporting are: financial, manufactured, human, social & relationship, intellectual and natural.

These capitals coincides with the seven "capitals" addressed by CTAs. CTAs assign equal weight to human capital, physical capital, economic capital, natural resources capital, social capital, cultural capital, and institutional capital. The second image (EPA, 2016) confirms that these capitals are similar to the same capitals, or Scope, of several international climate change resiliency assessment frameworks. The third image (MOVE, 2011) confirms that these are the same capitals used by some disaster risk assessment frameworks. The images displayed in the previous section, Section D. Standards, confirm that existing financial reporting systems, such as GRI and SASB, also use similar "categories", or capitals. The IPCC WG2 and IPBES (2016a)

references explain how these capitals, including institutional capital and cultural capital, influence decision making processes aimed at protecting and improving resource stocks.

The six capitals used in the Integrated Reporting Framework can be readily addressed by these more comprehensive capitals (i.e. financial = economic, manufactured = physical, intellectual = part of economic). They provide further evidence that CTAs can readily provide background, transparent, proof for the claims reported using financial accounting systems.

2.8 Externalities may be positive or negative (i.e., they may result in a net increase or decrease to the value embodied in the capitals). Externalities may ultimately increase or decrease value created for the organization; therefore providers of financial capital need information about material externalities to assess their effects and allocate resources accordingly.

2.9 Because value is created over different time horizons and for different stakeholders through different capitals, it is unlikely to be created through the maximization of one capital while disregarding the others. For example, the maximization of financial capital (e.g., profit) at the expense of human capital (e.g., through inappropriate human resource policies and practices) is unlikely to maximize value for the organization in the longer term.

2C The capitals

The stock and flow of capitals

2.10 All organizations depend on various forms of capital for their success. In this Framework, the capitals comprise financial, manufactured, intellectual, human, social and relationship, and natural, although as discussed in paragraphs 2.17–2.19, organizations preparing an integrated report are not required to adopt this categorization.

2.11 The capitals are stocks of value that are perspective[1], it demonstrates the continuous interaction and transformation between the capitals, albeit with varying rates and outcomes.

2.13 Many activities cause increases, decreases or transformations that are far more complex than the above example and involve a broader mix of capitals or of components within a capital (e.g., the use of water to grow crops that are fed to farm animals, all of which are components of natural capital).

2.14 Although organizations aim to create value overall, this can involve the diminution of value stored in some capitals, resulting in a net decrease to the overall stock of capitals. In many cases, whether the net effect is an increase or decrease (or neither, i.e., when value is preserved) will depend on the perspective chosen; as in the above example, employees and employers might value training differently. In this Framework, the term value creation includes instances when the overall stock of capitals is unchanged or decreased (i.e., when value is preserved or diminished).

Categories and descriptions of the capitals

2.15 For the purpose of this Framework, the capitals are categorized and described as follows:

- *Financial capital* – The pool of funds that is:
  - available to an organization for use in the production of goods or the provision

Table 1. Example frameworks to assess community resilience to climate change

Framework	Scope	Resilience Concept	Indicator Approach
Rockefeller Foundation's 100 Resilient Cities (ARUP's City Resilience Framework) http://www.100resilientcities.org/resilience#/-_/ http://publications.arup.com/publications/c/city_resilience_framework	Health & Wellbeing; Economy & Society; Infrastructure & Environment; Leadership & Strategy	"The capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience."	Qualitative indicators that are "driver" statements representing actions that improve cities' resilience (e.g., Infrastructure: provide reliable communication and mobility; Economy & Society: ensure social stability, security, and justice)
Assessments of Impacts and Adaptation of Climate Change (AIACC) sustainable livelihood approach http://www.start.org/Projects/AIACC_Project/working_papers/Working%20Papers/AIACC_WP_No017.pdf	Natural capital, financial capital, physical capital, human capital, social capital	Improving the quality of life without compromising livelihood options for others	Quantitative and qualitative indicators that measure communities' ability to cope with and recover from shocks and stresses, economic efficiency and income stability, ecological integrity, and social equity
UK Department for International Development Building Resilience and Adaptation to Climate Extremes and Disasters framework (BRACED) http://www.braced.org/resources/i/?id=cd95acf8-68dd-4f48-9b41-24543f69f9f1	Adaptive capacity (assets and income, strength and adaptability of livelihoods, availability and use of climate change information, basic services for vulnerable populations); Anticipatory capacity (preparedness and planning, capacity, coordination and mobilization, risk information); Absorptive capacity (savings and safety nets, substitutable and diverse assets and resources); Transformation (leadership, empowerment and decision-making processes, strategic planning and policy, innovative processes and technologies)	"Ability to anticipate, avoid, plan for, cope with, recover from and adapt to (climate related) shocks and stresses."	Quantitative and qualitative indicators that span climate change impacts data, economic data, livelihood data, ecological data, social and institutional data, and data on planning and decision making processes

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3 DRAFT—DO NOT CITE OR QUOTE

Framework	Scope	Resilience Concept	Indicator Approach
UNDP Community-Based Resilience Analysis (CoBRA) Framework http://www.undp.org/content	Natural capital, financial capital, physical capital, human capital, social capital	"Inherent as well as acquired condition achieved by managing risks over time at individual, household, community and societal	"Composite set of context-specific multi-sectoral quantitative and qualitative resilience indicators." This process tool enables communities to identify key building blocks of

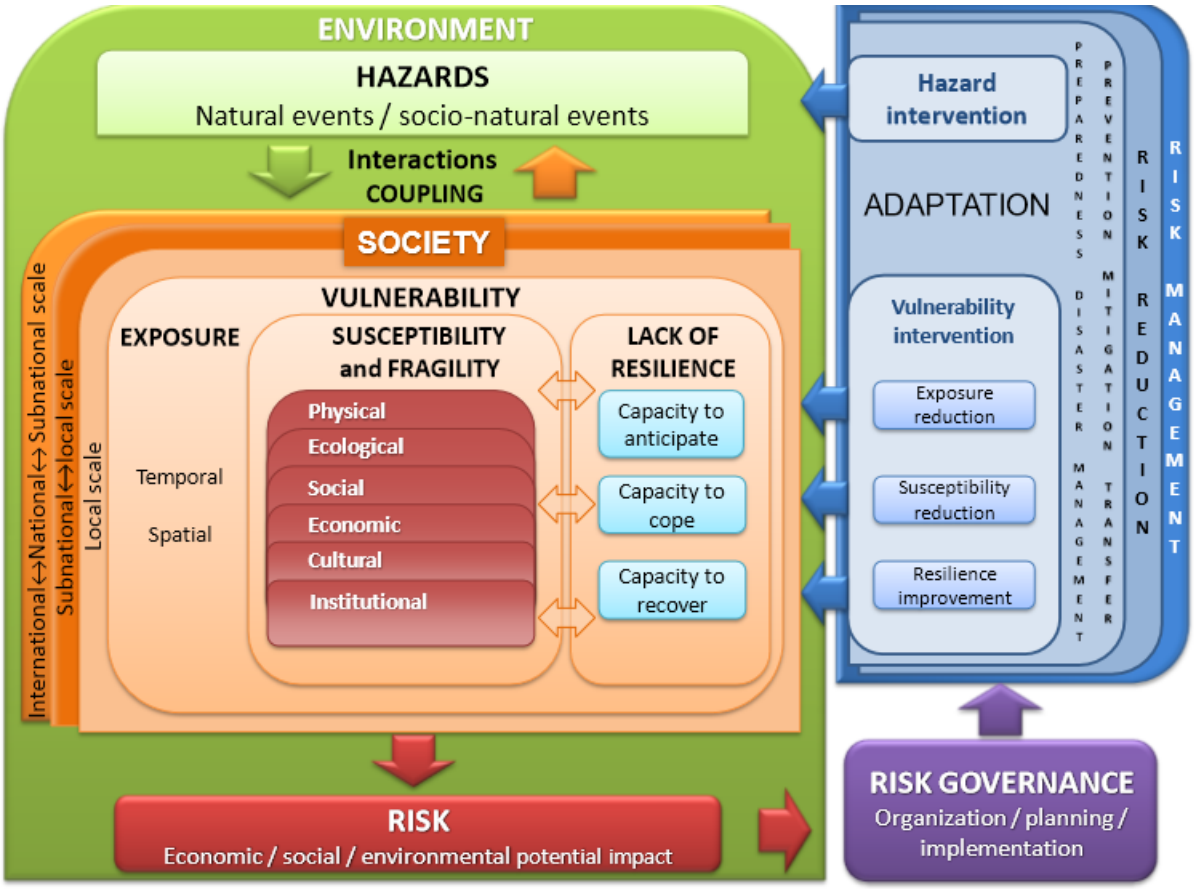
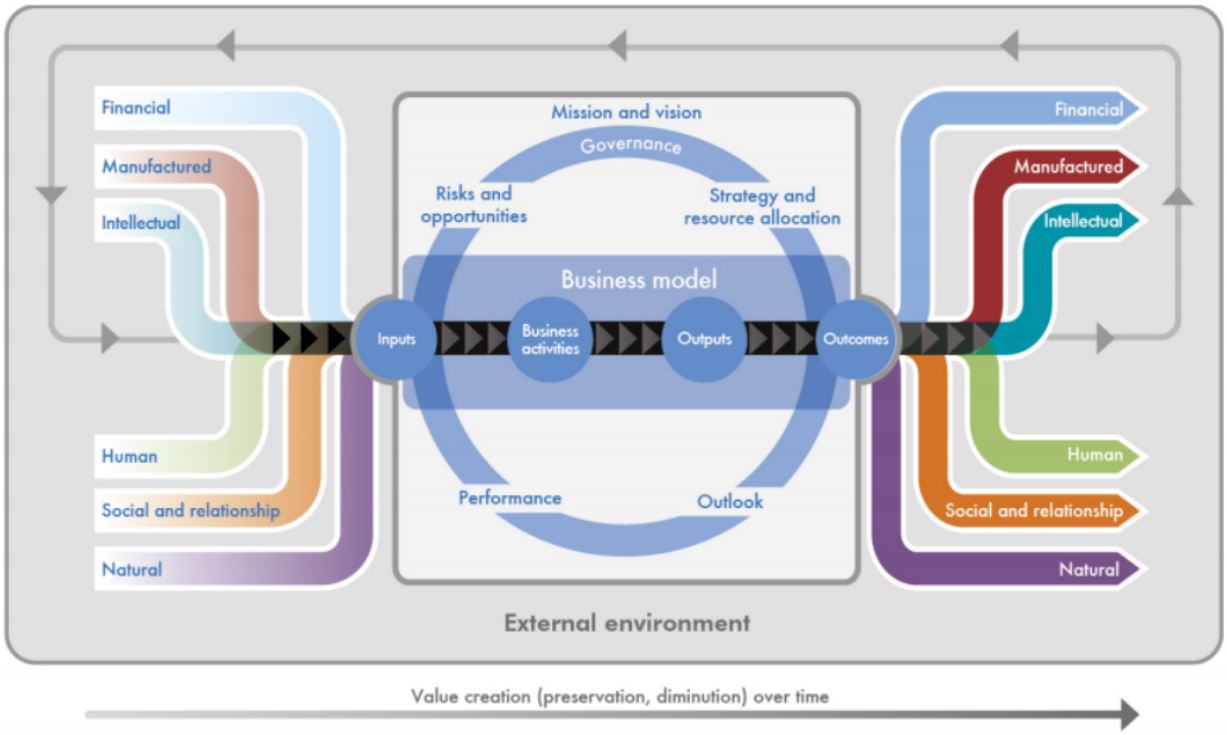


Figure 3: MOVE conceptual framework of a holistic approach to disaster risk assessment and management.

The following image (IIRC, 2013) depicts the "value creation process" that some standards-settings groups use as the foundation for financial reporting. Note carefully the Business Model at the center of the image. The Inputs, Activities, Outputs, and Outcomes in the model coincide closely with the framework presented in the Monitoring and Evaluation (M&E) and Resource Stock tutorials. The M&E and Resource Stock frameworks extend this model further by emphasizing the need to measure Impacts. That is, what evidence exists that money has been, or is being, spent well? Have lives and livelihoods actually improved? How much value has really been created?

In effect, this "value creation process" coincides with the "social value conservation process" explained in this reference for preserving and improving public capital stocks.

Figure 2: The value creation process:



www.theiirc.org The International <IR> Framework 13

The following image (IASB, 2013) confirms that the CTA emphasis on using basic tools grounded in economics and resource conservation to measure the risk and uncertainty of resources conservation data is consistent with current efforts to improve international financial reporting.

Allowances must be made about differences between how resource conservationists and accountants use terms such as “equity” and “net returns”. For example, conservationists use the term “equity” to denote the fair distribution of benefits across society. They use amortization, rather than cash flows or double entry book keeping, to define “net returns”.

EXPOSURE DRAFT—MAY 2015

Question 1—Proposed changes to Chapters 1 and 2

Do you support the proposals:

(a) to give more prominence, within the objective of financial reporting, to the importance of providing information needed to assess management's stewardship of the entity's resources;

(b) to reintroduce an explicit reference to the notion of prudence (described as caution when making judgements under conditions of uncertainty) and to state that prudence is important in achieving neutrality;

(c) to state explicitly that a faithful representation represents the substance of an economic phenomenon instead of merely representing its legal form;

(d) to clarify that measurement uncertainty is one factor that can make financial information less relevant, and that there is a trade-off between the level of measurement uncertainty and other factors that make information relevant; and

(e) to continue to identify relevance and faithful representation as the two fundamental qualitative characteristics of useful financial information?

Why or why not?

Chapter 3—Financial statements and the reporting entity

The following images (GSSB, 2016, SASB, 2016) demonstrate typical content found in "socially sound" accounting reports. The top image shows that standards for disclosures include both requirements and recommendations for reporting. Note that "item c" in the top box requires firms to report on the "calculation tools" used for the disclosure. The bottom image shows that, in many cases, much of a report's content involves quantitative measurements.

CTAs offer a modern, flexible, transparent, open source, algorithm-driven, set of online scientific tools for these calculations and measurements. Importantly, they also include tutorials demonstrating how to replicate the reported results. For example, many of DevTreks' tutorials demonstrate using a "Change by Time Analysis" to produce reports very similar to the second image (i.e. refer to the Change Analysis 1 tutorial).

Disclosure 302-5
Reductions in energy requirements of products and services

Reporting requirements

Disclosure 302-5

The reporting organization shall report the following information:

a. Reductions in energy requirements of sold products and services achieved during the reporting period, in joules or multiples.

b. Basis for calculating reductions in energy consumption, such as base year or baseline, including the rationale for choosing it.

c. Standards, methodologies, assumptions, and/or calculation tools used.

Reporting recommendations

2.9 When compiling the information specified in Disclosure 302-5, the reporting organization should:

2.9.1 if subject to different standards and methodologies, describe the approach to selecting them;

2.9.2 refer to industry use standards to obtain this information, where available (such as fuel consumption of cars for 100 km at 90 km/h).

Guidance

Guidance for Disclosure 302-5

Use-oriented figures can include, for example, the energy requirements of a car or a computer.

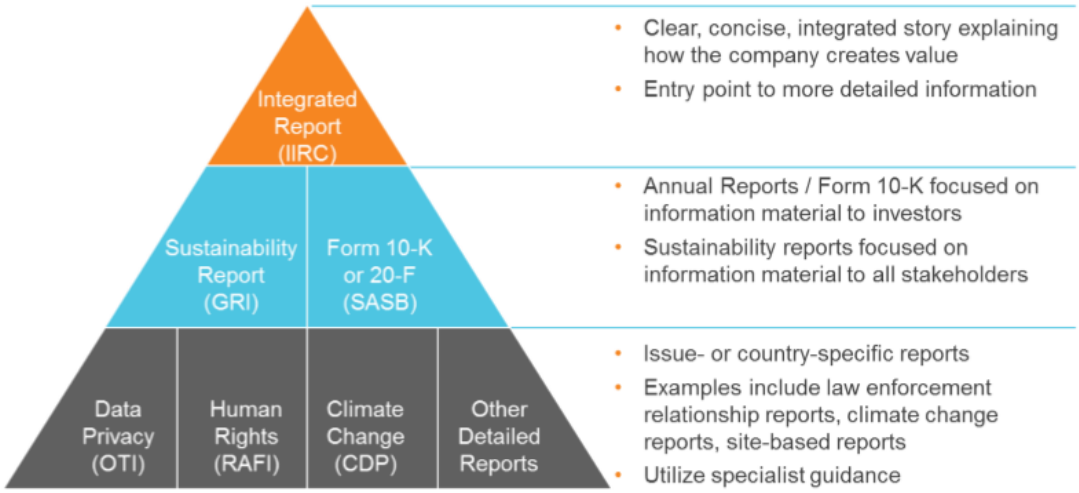
Consumption patterns can include, for example, 10 percent less energy use per 100 km travelled or per time unit (hour, average working day).

Table 1. Summary of Quantitative Accounting Metrics

Disclosure Topic	Metric	Year Ended December 31, 2012	2013	2014
Materials Efficiency and Recycling	Total waste from manufacturing (in metric tons)	406,973	369,867	353,839
	Percentage recycled	82%	85%	86%
	Weight of end-of-life material recovered (in metric tons)	2,560,710	2,639,907	2,721,554
	Percentage recycled	67%	74%	75%
	Average recyclability of vehicles sold, by weight (sales-weighted, in metric tons)	79%	83%	85%
Product Safety	Percentage of models holding overall 5-star safety rating, North America	68%	67%	70%
	Percentage of models holding overall 5-star safety rating, Europe	81%	83%	83%
	Percentage of models holding overall 5-star safety rating, Australia/New Zealand	54%	54%	57%
	Percentage of models holding overall 5-star safety rating, Asia	64%	64%	65%
	Percentage of models holding overall 5-star safety rating, South America*	0%	0%	0%
	Number of safety-related defect complaints	1,204	1,193	987
	Percentage investigated	.4%	.3%	.4%
	Number of vehicles recalled (in thousands)	572	493	1,234
Labor Relations	Percentage of U.S. workforce covered by collective-bargaining agreements	17%	17%	17%
	Percentage of foreign workforce covered by collective-bargaining agreements	31%	31%	31%
	Number of strikes and lockouts	0	0	0
	Total duration of strikes and lockouts (in worker days idle)	0	0	0
Fuel Economy and Use-phase Emissions	Sales-weighted average fleet fuel economy, U.S. domestic passenger cars (MPG)	33	34	34.5
	Sales-weighted average fleet fuel economy, U.S. light trucks (MPG)	25	26	26.5
	Sales-weighted average fleet emissions, E.U. passenger cars (g CO_2/km)	134	132	130
	Sales-weighted average fleet emissions, E.U. light commercial vehicles (g CO_2/km)	190	180	180
	Sales-weighted average fleet fuel economy, passenger cars sold in Japan (km/L)	17	17	17.5
	Sales-weighted average fleet fuel economy, Australia/New Zealand (L/100 km)	6.9	6.5	6.4
	Sales-weighted average fleet fuel economy, Asia (excluding Japan) (km/L)	17	17	17.5

The top image below (Allison-Hope, 2016) summarizes a recent proposal for the future advancement of these "socially sound" reporting techniques. CTAs support, in particular, the bottom segment of this triangle. For example, the Technology Assessment 2 tutorial demonstrates how CTAPs can be used to supply scientific evidence of how mitigation and adaptation technologies lessen the risk of damages caused by climate change.

The bottom image below (IFAC, 2016) makes clear that the nature of public sector financial reporting means that conventional performance measurements, such as Net Returns and Return on Investment, must be supplemented with alternative assessments of public sector performance. The techniques introduced in the Technology Assessment 2 tutorial also demonstrate how CTAPs can be used to supply these alternative assessments, including Disaster Risk Indexes, Resiliency Indexes, Risk Management Indexes, Multi-Criteria Assessments, Cost-Benefit Analyses, and Cost-Effectiveness Analyses.



At the top of the triangle there is huge value in a clear, concise, and integrated story that explains how the company creates value for both shareholders and society at large. This offers an entry point to more detailed information available elsewhere and is where the IIRC Integrated Reporting Framework can be used.

THE CONCEPTUAL FRAMEWORK FOR GENERAL PURPOSE FINANCIAL REPORTING BY PUBLIC SECTOR ENTITIES

The Preface to the Conceptual Framework for General Purpose Financial Reporting by Public Sector Entities

Introduction

1. The Conceptual Framework for General Purpose Financial Reporting by Public Sector Entities (the Conceptual Framework) establishes the concepts that are to be applied in developing International Public Sector Accounting Standards (IPSASs) and Recommended Practice Guidelines (RPGs) applicable to the preparation and presentation of general purpose financial reports (GPFRs) of public sector entities 1.

2. The primary objective of most public sector entities is to deliver services to the public, rather than to make profits and generate a return on equity to investors. Consequently the performance of such entities can be only partially evaluated by examination of financial position, financial performance and cash flows. GPFRs provide information to users for accountability and decision-making purposes. Therefore, users of the GPFRs of public sector entities need information to support assessments of such matters as:

   - Whether the entity provided its services to constituents in an efficient and effective manner;
   - The resources currently available for future expenditures, and to what extent there are restrictions or conditions attached to their use;
   - To what extent the burden on future-year taxpayers of paying for current services has changed; and
   - Whether the entity's ability to provide services has improved or deteriorated compared with the previous year.

F. Social Performance Measures and Examples

Appendix B. Social Performance Measures introduces the algorithms used to measure specific Social Performance Measures, including the Total Social Risk Score for Companies and Communities, Life Cycle Assessments, and Life Cycle Benefit and Cost Assessments. **Appendix C. Social Performance Examples** presents online examples of these Measures.

Future releases will include additional Social Performance Measures and examples.

Summary and Conclusions

Clubs using DevTreks can start to carry out the basic analysis of the impacts that companies and public entities have on their community's stocks of human capital, physical capital, economic capital, natural resources capital, social capital, cultural capital, and institutional capital. Clubs can solicit help understanding social performance better and share structured evidence explaining social performance. Networks can build knowledge banks that explain social performance and pass that knowledge down to future generations. Investors, customers, and informed citizens can use the information in the knowledge banks to take concrete action to support good actors and to chasten bad actors.

Measuring social performance is a precursor to improving societal performance (**7***). Society improves by understanding, protecting, and improving the public services generated by public capital stocks. Doing a better job of collecting, measuring, aggregating, analyzing, sharing, and explaining, social performance data can help people to improve their lives and livelihoods.

Footnotes

1. Most of this reference derives from the author's experience working as an agricultural economist for the USDA, Natural Resources Conservation Service and a rural credit lender for the USDA, Farmers Home Administration. The author spent more than 15 years working as a full time economist on natural resources conservation issues. An additional 10 years was spent as a rural lender reviewing agricultural firms' financial statements, income statements, and cash flows (as well as putting farmers and ranchers in and out of business based on that evidence). He made the connection between the conservation of scarce resources and financial reporting decades ago, but didn't have time to fully build tools that complement financial and scientific resource accounting until he founded DevTreks about a decade ago.
2. Readers should be aware that plenty of professionals and practitioners in the fields of "capital improvement" can do a better job explaining these subjects and presenting examples. The key value-added that DevTreks brings to the table are the actual information technology tools needed to carry out these practices. DevTreks would not be producing this reference unless the source code was "freely" available to back up the

recommendations in this reference. [In fact, nothing is free with information technology – good IT requires hard work]. As usual, DevTreks encourages source code users to produce their own tutorials, references, and algorithms that target the needs of their own customers.

3. To bring this statement down to earth, particularly in 2017, in a very real sense it doesn't matter anymore who leads government agencies, like the US Environmental Protection Agency. Customers, investors, and informed citizens, have far more power. That power is realized at scale and scope when they fully exploit the nascent online tools that are available to satisfy their demand for socially sound private and public sector behavior and then use their code, purses, wallets, and ingenuity to take appropriate actions.

4. Another key distinction from financial accountants is the mentality of the resource conservationists as expressed by their attire. They're usually the ones in the meetings wearing the tee shirts, flannel shirts, and jeans. They are also the ones more likely to understand the significance of "$28" donations, and the need to include farmworkers and factory workers in the corporate audience. As mentioned in several tutorials, DevTreks takes the long view about how attitudes and technologies evolve to accomplish these "best resource conservation accounting practices". That "long view" is measured in technological development and adoption time. Refer to the definition of Technology Development, Diffusion, and Adoption in Appendix D.

5. Importantly, the resource conservationists and their supporting technologists may be good examples of the "new economy" jobs that people seem so distressed about. Rural residents should understand that, although many of the examples and references appear to focus on multi-national corporations, these tools, and jobs, are fully applicable to rural areas, including towns and villages, and rural companies, including farms and ranches. In the U.S., their local Conservation Districts and the District employees, which the author has worked extensively with in the past, may be good examples. Because of the need to effectively gather and analyze objective, scientific evidence that also identifies and deals with bad actors, new types of resource conservationists and Conservation Districts may be needed (i.e. conservation technology assessors and Conservation Technology Assessment Districts based primarily on the cloud to avoid local pressure).

6. The existing standards-setting groups appear to miss this connection. A WBS may sound pedestrian, and not worthy of attracting money or being taken seriously, compared to "international sustainability reporting standards". This reference tries to make the case that the systems complement one another (and might contain a lot of the same elements).
7. The chairman of the Task Force on Climate Related Financial Disclosures (2016), Michael Bloomberg, phrases this as "What gets measured better gets managed better". Daniele Giovannucci of the Committee on Sustainability Assessment (COSA via UNFSS 2016) cites the adage "you cannot manage what you cannot measure". This reference would add "what gets measured well, gets purchased more often and attracts more investments".
8. In other words, a group of bandits, or, as some rural friends the author has known might say, rural sociopaths, can't descend on public land and claim ownership because they don't personally like public ownership of goods, services and assets or because they want to personally gain from the exploitation of public goods.
9. For example, Miller (NYT, 2016) quotes economists who have found that "Over the long haul, … automation has been much more important [to explain the loss of well-paying jobs than open trade and immigration] –it's not even close." That is, technological changes that lead to higher productivity drives much of economic development. New institutions are needed that can embrace, learn, and adapt, open source code to improve local economic development.
10. Although finding good online data for the drought case study presented in the CTAP reference proved futile.
11. A reminder –it may be the role of a software development company to provide basic resource accounting value frameworks and applied algorithms, but that role is the full time job of social networks and their clubs. For example, the author has trained resource conservationists to use an applied version of this framework for conservation planning (i.e. USDA, NRCS, Soil, Water, Air Plants, Animals, and Humans). The principle advantage to that approach was its comprehensiveness –eroded soil effected crop yields but also effected stream water quality, which in turn, effected fisheries and fishing economies. The principle disadvantages included extensive and complicated paperwork,

reliance of subject matter specialist subjective knowledge in defining and applying indicator thresholds (i.e. plus 3 = highly positive impact; minus 3 = highly negative impact), difficulty fully understanding the interactions between local conservation and regional conservation, and fully applying the results to local farms and ranches. These frameworks and applied algorithms require the full time commitment of the new technology-oriented and social network-based institutions advocated in this reference (i.e. refer to Footnote 12's institutional factors and refer to recent news reports introducing new AI startups).

12. As another example of "doing it right", interpret the following question: "Other than institutional factors, is there any technical reason that Social Performance Measures can't be completed online, stored uniformly online, and easily accessed online by people and machines, for every company and public entity in the world?". After all, if an investment rating company with a few hundred employees can complete E.S.G. ratings for thousands of companies, what can online social networks and their clubs accomplish?

13. And by the natural resource conservation sector - the IPBES (2016b) reference is the equivalent of a Health Technology Assessment (HTA) that "assess[es] animal pollination as a regulating ecosystem service underpinning food production in the context of its contribution to nature's gifts to people and supporting a good quality of life".

14. The specific reason that DevTreks relies on the generic terms "social networks and clubs" throughout its tutorials (i.e. Footnotes 11, 12, and the Summary) is so that no assumptions need to be made about the capacity for innovation and inclusiveness within conventional institutions (i.e. including high-faluting ones). Many have lost, and continue to lose, their credibility. This aligns with Ramnath and Child's (2017) conclusion that "traditional criteria for judging research merit such as - citations, peer reviews, and other bibliometric approaches, are not measuring up as useful measures of research effectiveness".

15. The danger of having one IT company dominate this field can be lessened by carefully following the directions suggested in this reference.

16. In additional other words, carried out by people in well-paying, local jobs focused on improving the public services generated by public capital stocks.

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References Note

We try to use references that are open access or that do not charge fees.

Improvements, Errors, and New Features

Please notify DevTreks (devtrekkers@gmail.com) if you find errors in these references. Also please let us know about suggested improvements or recommended new features.

Video tutorials explaining this reference can be found at:

Two Social Analysis video tutorials can be found in this resourcepack.

https://www.devtreks.org/commontreks/preview/commons/resourcepack/Performance Analysis 1/509/none

Appendix A. Resource Conservation Value Accounting Framework (11*)

This conceptual framework derives from techniques applied in the natural resources capital protection and improvement field, particularly climate change and biodiversity protection, because much of the most recent and best resource conservation accounting and risk assessment science is being carried out for that public capital stock. The framework is applied to assess all public capital stock services.

A. Principles

In the context of DevTreks, a good Resource Conservation Accounting reporting system follows the Financial Accounting principles already defined in this reference along with the following public capital-accounting principles.

1. **Supports Science-based Resource Allocation Decisions**. Reporting must be grounded in a science that supports decisions for allocating scarce resources well. Those resources comprise a community's stock of human capital, physical capital, economic capital, natural resources capital, social capital, cultural capital, and institutional capital. Physical stock balances are mainly important to the degree that they generate services demanded by people. Changes in stock balances and resultant public services must be measured and reported in terms of costs, benefits, productivity, tradeoffs, and performance.
2. **Reports the Risk and Uncertainty of Stock Balances**. Reporting must account for the risk and uncertainty of measuring resource conservation actions and valuing changes in stock balances. That is, it must present final qualitative and quantitative measurements, and price financial risk, in terms of scenarios, ranges, thresholds, and confidence intervals.
3. **Supports Transparent Corporate and Public Sector Materiality Reporting**. Reporting must help investors, customers, and informed citizens to take concrete action to support good actors and to chasten bad actors. That is, it must use online tools and produce online results that support the financial accounting principle of materiality.

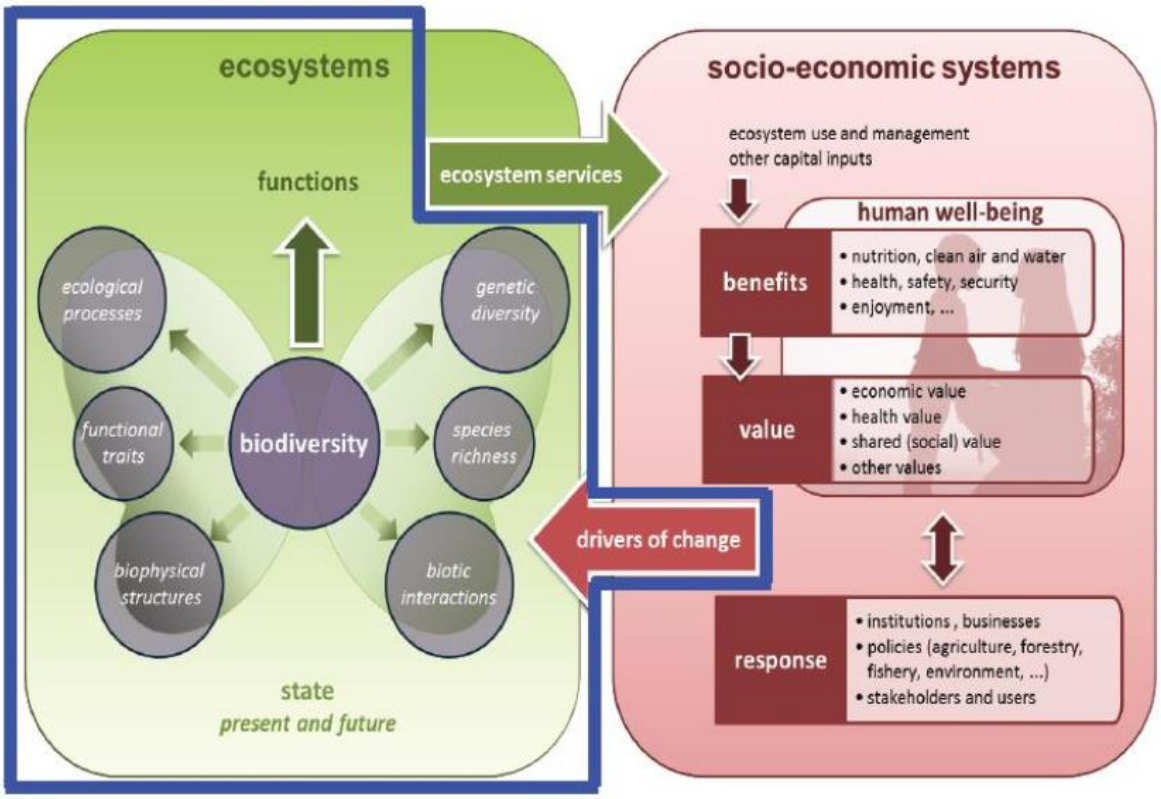
4. **Improves Institutions Over Time**. Reporting must use adaptive management, or "adaptive efficiency", applied over time, to improve formal and informal institutions. That is, it must use online tools and produce online results that help investors, customers, and citizens, to become socially sound investors, consumers, and community participants.
5. **Leads to the Rapid Adoption and Use of Online Knowledge Banks**. Reporting must lead to the faster diffusion and adoption of its applied, online, tools.
6. **Promotes Experimentation and Gains Experience**. These reporting techniques may be exactly what are *not* needed to conserve scarce resources. People need to be experimenting and increasing their experience if global resources are to be conserved affordably and transparently.

B. Summary, Resource Conservation Value Accounting Framework

This section summarizes the resource conservation accounting framework used in this reference for measuring social performance. The remaining sections of this Appendix explain this framework in greater detail.

The following image (European Environment Agency, 2016) summarizes a conceptual framework currently being used for ecosystem assessment in the European Union (EU). To summarize this framework, changes in ecosystem conditions, or state, are caused by drivers (of change) rooted in the ecosystem services generated by ecosystem capital stocks. Humans derive benefits from these ecosystem services resulting in their demand for levels of service quantity and quality that will increase their quality of life. Changes in demand for services or deterioration in the existing supply of highly demanded services, result in human responses, or mitigation and adaptation actions, designed to protect or improve the services. These responses change the ecosystem conditions thereby changing their service flows.

Figure 2.2 Conceptual framework for EU-wide ecosystem assessment



Note: The blue box frames the content of the ecosystem condition assessment described in this report.

Source: Maes et al., 2013.

The following image (IPBES, 2016a) summarizes a similar, but more nuanced, version of the conceptual framework currently being used for ecosystem assessment by a scientific organization affiliated with the UN. The primary nuance derives from their explicit acknowledgement that different stakeholders place different values on ecosystem services (i.e. the blue text). The nuances are particularly important to understand because they explain why many resource stocks have been overexploited or allowed to deteriorate –powerful interest groups placed greater value on what they could personally derive from the public stock rather than what was best for the common good.

Further descriptions of the IBPES framework (i.e. Chapter 1 in their "scenarios and models" 2016a reference, Appendix 1 in their "pollinators" 36 page reference and the Preface to their 552

page reference) distinguish between “indirect drivers of change”, rooted in the socio-economic systems displayed in the EAA framework (i.e. government policy, societal demand for housing, company production process causing air pollution), and “direct drivers of change” that directly change natural resource stock conditions (i.e. conversion of farmland to residential land uses; reduced air quality). The natural resource stock changes result in changes to the structure and function of ecosystems which change the services they generate. The changes to services result in “nature’s benefits” that can change the quality of life experienced by specific stakeholder groups.

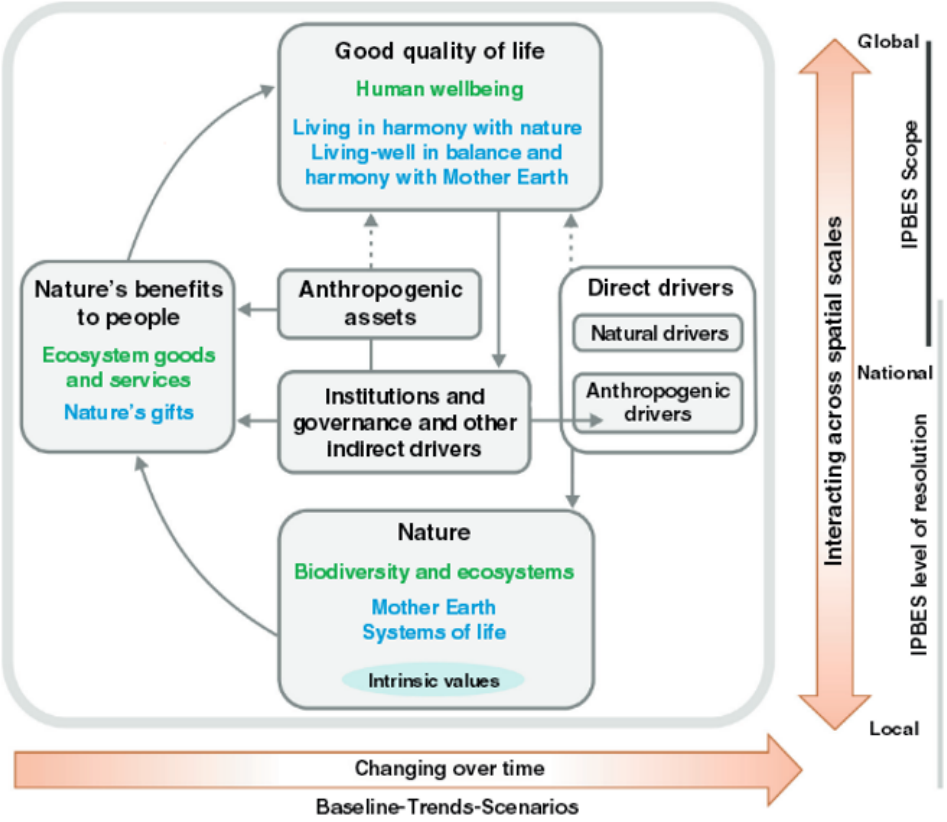


Figure 1.2: The IPBES Conceptual Framework, modified from Díaz et al. (2015). This depicts the main elements and relationships for the conservation and sustainable use of biodiversity and ecosystem services, human well-being and sustainable development. Similar conceptualisations in other knowledge systems include 'living in harmony with nature' and 'Mother Earth', among others. In the main panel (delimited in grey), 'nature', 'nature's benefits to people' and 'good quality of life' (indicated as black headlines) are inclusive of all these world views; text in green denotes the concepts of science; and text in blue denotes those of other knowledge systems. Solid arrows in the main panel denote influence between elements; the dotted arrows denote links that are acknowledged as important but are not the main focus of the Platform. The thick coloured arrows below and to the right of the central panel indicate different scales of time and space.

The following image (EMAS, 2017) summarizes the framework employed by a financial reporting system, the Eco-Management and Audit Scheme (EMAS), currently being used in Europe as "a management tool for companies and other organisations to evaluate, report and improve their environmental performance". Their definition for these terms include "Environmental aspect means an element of an organisation's activities, products or services that has or can have an impact on the environment. Environmental aspects may be input related

(consumption of raw materials and energy, for instance) or output related (air emissions, waste generation, etc.).”

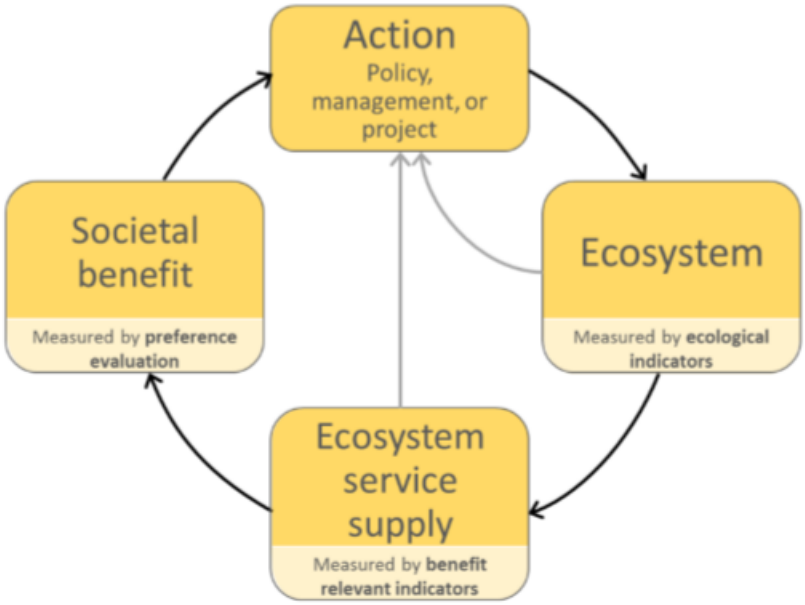
Figure 3

Relation between activities, environmental aspects and environmental impacts

Hammerl et al (2016) demonstrate how this reporting system works in the context of improving biodiversity and preserving ecosystem services. They elaborate on the latter term as follows: “The purpose of introducing the concept of 'ecosystem services' is to consider ecological services more readily in decision-making processes, estimate their (economic) value and motivate decision makers to reduce the excessive use and degradation of the natural basis providing those ecosystem services. A loss of biodiversity results in the reduction of the quality of the assets and services provided by nature, thus impinging on businesses in almost every branch of industry. Major businesses have recognised the preservation and protection of biodiversity to be of utmost importance. For this reason, firm anchoring of the ecosystem service approach within the entrepreneurial goals of a business is an essential prerequisite for ensuring success.”

To implement Hammerl et al (2016) guidelines, this RCA Framework inserts another box, Environmental Services, between Environmental Aspects and Environmental Impacts, similar to the ecosystem service causal chain, or social impact pathway, displayed in the following image (Olander et al, 2015: Activities = Actions, Aspects = Ecosystem, Environmental Services = Ecosystem Services, and Impacts = Societal Benefit). Antonopoulos et al (2016) demonstrate how to apply the reporting system in specific economic sectors, such as agriculture. These references recommend several performance indicators that can be used for reporting.

Figure 3. Components of an ecosystem service causal chain



The following image (Natural Capital Coalition or NCC, 2016) summarizes part of an applied decision support framework, the Natural Capital Protocol, currently being used for natural capital assessments by private sector companies. The 3 steps highlighted in this image, or impact and dependency pathways, can be derived directly from the EAA, IBPES, and EMAS Conceptual Frameworks (i.e. impact and dependency drivers = indirect and direct drivers of change or activities/products/services; natural capital state = ecosystem state, direct drivers of change that impact nature, or environmental aspects; value impacts and dependencies = ecosystem service valuation, nature's benefit measurement, or environmental impacts). The 9th step of this framework, Take Actions, coincide with Responses displayed in the EAA framework and the "indirect drivers of change" found in the IBPES framework. The IBPES concern about stakeholder values is incorporated throughout this process (i.e. Step 1, Scoping). This 9 step process is further explained with the decision support processes introduced later in this Appendix.

NATURAL CAPITAL PROTOCOL
Measure and value stage

MEASURE AND VALUE STAGE
How?

The Measure and Value Stage involves three linked Steps:

Step	Questions each Step will answer	Actions
05 Measure impact drivers and/or dependencies	How can your impact drivers and/or dependencies be measured?	5.2.1 Map your activities against impact drivers and/or dependencies
		5.2.2 Define which impact drivers and/or dependencies you will measure
		5.2.3 Identify how you will measure impact drivers and/or dependencies
		5.2.4 Collect data
06 Measure changes in the state of natural capital	What are the changes in the state and trends of natural capital related to your business impacts and/or dependencies?	6.2.1 Identify changes in natural capital associated with your business activities and impact drivers
		6.2.2 Identify changes in natural capital associated with external factors
		6.2.3 Assess trends affecting the state of natural capital
		6.2.4 Select methods for measuring changes
		6.2.5 Undertake or commission measurement
07 Value impacts and/or dependencies	What is the value of your natural capital impacts and/or dependencies?	7.2.1 Define the consequences of impacts and/or dependencies
		7.2.2 Determine the relative significance of associated costs and/or benefits
		7.2.3 Select appropriate valuation technique(s)
		7.2.4 Undertake or commission valuation

Additional notes

Before you start this Stage you should familiarize yourself with Step 08 in the Apply Stage, which covers interpreting and using assessment results, as there may be implications for Steps 05–07, depending upon your objective.

These groups use systems of Indicators to implement their frameworks (i.e. see EEA 2016, IPBES 2016a Chapter 8, EMAS Section 2.3.2.1, and NCC Section 5.2.2). This reference's Resource Conservation Value Accounting Framework adapts these frameworks by using

qualitative and quantitative Indicators from those systems to establish relationships and scenarios for the following 4 indicator paths.

Resource Stock Pathway 1 (i.e. Actions: EAA "drivers of change" and "responses"; IBPES "indirect drivers of change"; EMAS "activities, products, and services"; and NCC "impact drivers or dependencies"). Non-performing and non-existent actions (i.e. current practice) address the causal factors and barriers that explain current stock conditions and why stocks fail to deliver desired stock service levels. They help to explain benchmark stock conditions and services. New mitigation and adaption actions (i.e. responses) attempt to protect or improve stock conditions and services. They help to explain targeted stock conditions and services. Indicators measure the most significant actions as well as their expected trends.

Resource Stock Pathway 2 (i.e. Conditions: EAA "state of biodiversity and ecological functions"; IBPES "direct drivers of change that impact nature" "; EMAS "environmental aspects"; NCC "state of natural capital"). The state of an ecosystem corresponds to the condition of the 7 public capital stocks. The EAA (2017) defines ecosystem condition as "the capacity of ecosystems to deliver ecosystem services for human well-being depends on the condition of ecosystems, i.e. the quality of their structure and functionality. There is growing understanding of the importance of biodiversity in ecosystem functioning and service delivery, which represents our natural capital." That organization further defines conditions as "the effective capacity of an ecosystem to provide services, relative to its potential capacity." Indicators measure the current condition of priority capital stocks as well as expected trends with those assets.

Resource Stock Pathway 3 (i.e. Services: EAA "ecosystem services"; Hammerl et al "ecosystem services", IBPES "ecosystem services and nature's benefits" ". Demand to protect or improve resource stock conditions is driven by the services generated by the stocks (i.e. ecosystem services). The purpose of protecting or improving services is to generate benefits that coincide with the values and preferences held by diverse stakeholders. Indicators measure the most important services as well as expected trends with those services.

Resource Stock Pathway 4 (i.e. Impacts or Valuations: and Tradeoffs (EAA "ecosystem service values"; IBPES "quality of life" "; EMAS "environmental impacts"; NCC "value of natural capital impacts and dependencies"): The impacts of improvements in services are measured as enhancements to the quality of life of stakeholders. Different stakeholders value the services differently. Measuring these different valuations allow tradeoffs to be considered when making decisions that affect stock services, thereby lessening the potential public conflicts, or changed consumer demand for a company's products, arising from stakeholders who feel their values have been neglected. Indicators measure the impacts from changes in services as improvements to stakeholder quality of life.

Flexible Definitions of the 4 Pathways: This generic pathway is used because it accommodates a wide assortment of sustainability assessment tools. For example, Olde et al. (2016) review 48 sustainability assessment tools currently being used in the agricultural sector, most of which use 4 level indicator hierarchies. In addition, this type of Indicator combination can be used to support sustainability decision support tools that are based on "social impact pathways" (NCC 2016: Actions, Conditions, Services, and Impacts), "causal chains" (Olander et al 2015: Actions, Ecosystem State, Ecosystem Services, Societal Benefit), "exposure pathways" (USGCRP, 2016: Drivers, Exposure Pathways such as Dose-Response, Outcomes), "value creation process" (IIRC 2013: Inputs, Activities, Outputs, Outcomes), and "theory of change" or "results chains" (COSA, 2014 and Sustainable Food Lab, 2016: Activities, Outputs, Outcomes, Impacts).

The individual levels within the hierarchy can also be defined flexibly. For example, Actions in Level 1 can be defined several alternative ways: as company activities, performance objectives, as the capacity to respond effectively to vulnerabilities, drivers and pressures, or as the primary risks or stressors effecting stock conditions and services. Conditions in Level 2 can be defined in terms of biodiversity loss. If Services are defined for Level 3, they may focus on the supply of ecosystem services while Level 4's Impacts focus on their demand. The term "ecosystem services" can be replaced with whatever public service is being investigated in the capital stock assessment, such as cultural and institutional services.

Loconto et al (2014) summarize the practical importance of such Indicator "pathways" in product standards systems as follows: "In September 2010, the International Social and Environmental Accreditation and Labelling (ISEAL) Alliance published an Impacts Code with requirements for its members (standards systems) to help them understand the impact of their standards. Standards organizations are required to develop their theory of change or impact chain, i.e. the pathways through which the standard is likely to have certain impacts."

Indicator Thresholds: The current state of knowledge and technology limits the application of the framework to loosely defined relationships, or linkages, between the 4 Indicators. This becomes reinforced by this framework's extension beyond ecosystem services to cover all public services. In other words, full mathematical functions or CTA algorithms (i.e. IPBES models and linkages) can't be defined yet that jointly change, in the case of social impact pathways, Conditions, Services, and Impacts when Actions are taken. Subsequent sections of this Appendix address this reality, and the associated increase in the risk and uncertainty of stock assessment metrics, by introducing the use of qualitative and quantitative Indicator Threshold systems.

Quality of Life Scenarios. The current state of knowledge and technology limits the number of multi-stock Indicators, stakeholders, and spatial and temporal scales, which are used to define quality of life scenarios for realistic future "social impact pathways". For example, the remaining sections of this Appendix explains that, in the United States, federal agencies are required to apply a similar framework when assessing water and land resource projects, many of which are limited to single watersheds with general cost effectiveness objectives. The EEA (2017) reference introduces 5 socio-economic scenarios (Shared Socioeconomic Pathways or SSPs) that have been developed to complement IPCC climate change scenarios. Those SSPs provide logical Indicators that can help to define alternative Quality of Life scenarios.

Given the caveats presented in this section, the following example, further explained in subsequent sections of this Appendix, illustrates how these 4 hierarchical level can be applied in

tools introduced in Appendix B. The framework and planning process may become easier to understand and apply as more concrete examples are added to Appendix C (**10***).

Illustrative Community Example 1. Georgia Heat Wave (introduced in Appendix A, Section E. Indicator Threshold Overview)

Although, for simplicity, the following example demonstrates how the framework works for one simplistic natural resource capital stock scenario, such as a 1.5 degree temperature increase, the same process works for all public capital stocks, whether the scenario deals with the severe erosion of civil rights, major meddling with judicial systems, or significant interferences with public information access. This example demonstrates using a social impact pathway for the 4 hierarchical levels. The remaining sections of this Appendix and some of Appendix C's examples will address the deficiencies in this example, including the applied decision support processes, spatial and temporal scales, multiple service values held by multiple stakeholder groups for multiple stressor reductions, double counting, and the applied digital platform.

Indicator Thresholds

1. **Low Action Resiliency Threshold** = 1: low resiliency resulting from too little (<$2) per capita public expenditure per 100,000 vulnerable population
2. **High Action Resiliency Threshold** = 4: high resiliency resulting from appropriate (>$10) per capita public expenditure per 100,000 vulnerable population
3. **Low Condition Resiliency Threshold** = 1: 200% of target GHG levels result in unacceptable capacity to regulate climatic conditions
4. **High Condition Resiliency Threshold** = 4: 90% of target GHG levels result in acceptable capacity to regulate climatic conditions
5. **Low Service Threshold** = 1: 1 in 10 years have greater than 100% of critical heat wave threshold results in a very unacceptable level of risk for regulating climatic conditions
6. **High Service Threshold** = 4: 1 in 10 years have less than 25% of critical heat wave threshold results in a very acceptable level of risk for regulating climatic conditions

7. **Low Impacts Resiliency Threshold** = 1: 1 in 10 years have greater than 100 increased deaths per 100,000 vulnerable population resulting in 40% QOL satisfaction by stakeholder groups
8. **High Impacts Resiliency Threshold** = 4: 1 in 10 years have less than 10 increased deaths per 100,000 vulnerable population resulting in 70% QOL satisfaction by stakeholder groups

Scenario 1. Acceptable Quality of Life for Georgia citizens

9. **Impact Pathway:** Actions -> Conditions -> Services -> Impacts
10. **Stressors**: High GHG result in severe heat waves
11. **Targeted Stakeholder Groups**: Urban and rural residents of Georgia who can't reduce health risks caused by heat waves
12. **Performance Objective**: reduce deaths caused by heat waves
13. **Mitigation and Adaptation Actions**: Improvement 1 consists of a) …, b)…, and c)…. (i.e. BEMPs from publications like Antonopoulos et al, 2016)

Iteration 1. Resource Stock Assessment of Scenario 1

Indicator 1. Actions Scores (or Ratings)

14. **Benchmark Action Score** = 1: low resiliency resulting from too little (<$2) per capita public expenditure per 100,000 vulnerable population
15. **Target Portfolio 1 Action =** 4: high resiliency resulting from appropriate (>$10) per capita public expenditure per 100,000 vulnerable population

Indicator 2. Conditions Scores

16. **Benchmark Condition Score** = 1: 200% of target GHG levels result in unacceptable capacity to regulate climatic condition
17. **Target Portfolio 1 Condition** = 4: 90% of target GHG levels result in acceptable capacity to regulate climatic conditions

Indicator 3. Services Scores

18. **Benchmark Service Score** = 1: 1 in 10 years have greater than 100% of critical heat wave threshold results in a very unacceptable level of risk for regulating climatic services

19. **Target Portfolio 1 Service** = 4: 1 in 10 years have less than 25% of critical heat wave results in a very acceptable level of risk for regulating climatic services

Indicator 4. Impacts Scores

20. **Benchmark Impact Score** = 1: 1 in 10 years have greater than 100 increased deaths per 100,000 vulnerable population resulting in 40% QOL satisfaction by stakeholder group 1
21. **Target Portfolio 1 Impact** = 4: 1 in 10 years have less than 10 increased deaths per 100,000 vulnerable population resulting in 70% QOL satisfaction by stakeholder group 1

Iteration 1. Monitoring and Evaluation Assessment of Scenario 1

22. **Actual Action Score** = 2: moderate resiliency resulting from moderate ($2-$5) per capita public expenditure per 100,000 vulnerable population
23. **Actual Condition Score** = 2: 150% of target GHG levels result in acceptable capacity to regulate climatic conditions
24. **Actual Service Score** = 2: 1 in 10 years have 50 to 100% of critical heat wave threshold results in an unacceptable level of risk for regulating climatic services
25. **Actual Impact Score** = 2: 1 in 10 years have 50 to 100 increased deaths per 100,000 vulnerable population resulting in 50% QOL satisfaction by stakeholder group 1

Iteration 2: Benchmark Resource Stock Assessment Ratings = Iteration 1 Actual Ratings

Iteration n: Independent Institutional Improvement Score (by independent M&E specialists**)**

Illustrative Institutional Improvement Results

1. **Fair, Affordable, and Transparent Tradeoffs and Synergies are Understood:** Georgia uses Adaptive Management to fine tune the mitigation actions until deaths from heat waves are reduced to acceptable levels in transparent and affordable manners. Some citizens might find this approach heartless, especially if their elderly relatives are the "deaths", but the public funds spent on these mitigation actions might easily be spent on other public capital risks, or in other places, with much higher death rates. Every public and private sector expenditure is subject to tradeoffs and synergies. In effect, the values

and preferences of some stakeholders and consumers must be traded off to accommodate the values and preferences of other stakeholders and consumers. The goal is to understand these tradeoffs and synergies in order to reduce the risk of increased deaths, or negative impacts to capital stocks, in fair, transparent, affordable, and socially inclusive, ways.

2. **Root Causes are Acted Upon:** The heat wave deaths can't be avoided without a good understanding of the "drivers of change", or root causes, of the increased temperatures – what threshold levels has Georgia established for corporations to follow in reducing GHG? Which public sector policies and private sector behaviors contributed to these thresholds and deaths? Can these Institutional Capital Risks be mitigated now in a cost effective way rather than incur the potentially "disastrous" costs and deaths caused by the increased Natural Resources Capital risks? Can the free riders responsible for these increased Institutional Capital Risks and public expenditures be held accountable, now and in the future? Can the free riders be forced to pay their full share of the calamities when they occur (i.e. see EEA, 2017, USGCRP, 2016)? If policy makers' short term policies prove too risky and expensive for long term social soundness, what independent actions can a community or company take to increase resilience to those risks?

C. Vulnerability, Resiliency, and Risk Reduction

The following images (EPA, 2016) summarize a comprehensive framework for evaluating urban resiliency to climate change. This framework measures "the ability of a city to reduce exposure and sensitivity to, and recover and learn from gradual climatic changes or extreme climate events". This framework adapts these types of climate change resiliency definitions in the definition for "Public capital stock resiliency" found in Appendix D.

This framework improves this reference's resource accounting framework with several useful supplements.

- Resiliency to climate change is critically important for any resource conservation accounting framework. In the context of this reference, the desired resiliency is to corporate and public sector actions that negatively impact the services generated by public capital stocks. In the domain of climate change, important stressors to public capital stocks are efforts by firms and public entities to undermine, skirt, or not transparently support (i.e. via their financial reports and agency reports), efforts to improve a community's resilience to climate change-related disasters.
- The framework employs quantitative and qualitative Indicators and Indicator Thresholds to measure resiliency in a way that complements the Indicator measurements used in CTAs.
- The mitigation and adaptation Responses for reducing the negative risks associated with climate change are applied with Adaptive Management, or Learning, to result in actual Risk Reduction results. The Risk Reductions coincide with Disaster Risk Reduction techniques, including Vulnerability Assessment, introduced in the Technology Assessment 2 tutorial.

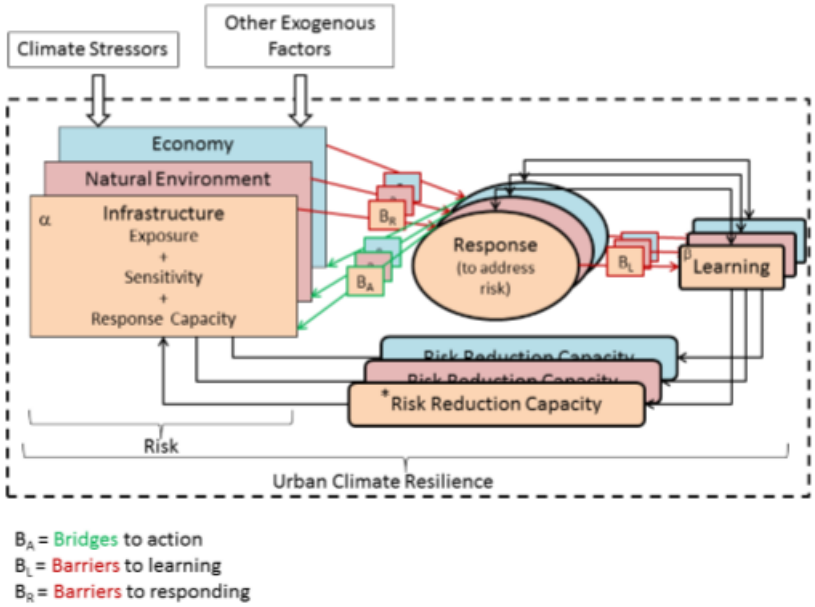


Figure 1. Urban climate resilience framework.

α These three elements—exposure, sensitivity, and response capacity—compose urban vulnerability.
β Learning outcomes are on three levels: reacting, reframing, and transforming (see Figure 1-3, IPCC, 2012). Examples: reacting—increase a levee height; reframing—realizing the need to assess new storm duration frequency distributions; transforming—assessing societal constructs and migrating to a more robust and comprehensive risk management strategy.
*Risk reduction capacity is the ability to reduce exposure, reduce sensitivity, and/or increase the system's inherent recovery potential in anticipation of harmful climatic changes/events.

In the framework itself, the left hand side focuses on anticipated future climate events and system responses. Included in this side are the potential exposures to climate change, both gradual and extreme, the potential sensitivity of sectors and systems to those exposures, and the theoretical capability to respond to anticipated climate changes (response capacity, also referred to as adaptive capacity in the climate change literature). The right side of the framework reflects actual responses to real world experiences (whether by the community itself or through observations of other communities and their experiences) of extreme weather events. Barriers to action and bridges to better-than-anticipated responses are identified based on reflections after an

Box 1. Working definitions.

Urban Climate Resilience: The ability of a city or urban system, through its risk reduction and response capacity capabilities, to reduce exposure and sensitivity to, and recover and learn from, gradual climatic changes or extreme climate events, in order to retain or improve the integrity of its infrastructure and economic systems, vital environmental services and resources, the health and welfare of its populations and communities, and the flexibility and diversity of its institutional and governance structures (adapted from Leichenko, 2011).

Exposure: The presence of people; livelihoods; environmental services and resources; infrastructure; or economic, social, or cultural assets in places that could be affected by climate change stressors (adapted from IPCC, 2012).

Sensitivity: Predisposition of human beings, infrastructure, society, and ecosystems to be affected by exposure to a climate stressor or an effect of that exposure (adapted from IPCC, 2012).

Response Capacity: Intrinsic capacity of a community to recover from alterations in its normal functioning due to gradual changes in the climate or to extreme events that result in adverse human, material, economic, or environmental effects.

Learning: Capability to recognize complex dynamics of socio-ecological systems in order to respond appropriately to risk and make effective adaptation responses, identifying mistakes and shortcoming in those responses following climate stressor events, and evolving as new information becomes available (drawn from IPCC, 2012; Kasperson, 2012). (Learning outcomes are on three levels: reacting, reframing, and transforming [see Figure 1-3, IPCC, 2012]. Examples: reacting—increase levee height; reframing—realizing the need to assess new storm duration frequency distributions; transforming—assessing societal constructs and migrating to a more robust and comprehensive risk management strategy.)

Bridges to Action: Conditions under which unforeseen and huge leaps are made in a community's ability to respond to and recover from alterations or disruptions in its normal functioning (e.g., due to social or technical innovation).

Risk: A function of the exposure to and severity of the occurrence of a particular type of climate change (gradual or extreme) and the way in which its consequences are likely to be mediated by the social vulnerability of the human system. Risk can be assessed in terms of condition and predictive variables representing factors such as economic well-being; health and education status; and preparedness and coping ability with respect to particular climatic changes.

Risk Reduction Capacity: Ability to reduce risk by reducing exposure and sensitivity or increasing recovery potential and adaptive capacity, to prepare for expected climatic changes or events.

Note: These definitions are considered operational definitions. Therefore, they might not be identical to the definitions in the current literature, but they have been selected for their appropriateness to this application.

The following changes describe how this framework has been adapted to the more general Resource Accounting Framework needed for this reference. The next section, Indicator Threshold Overview, demonstrates how to use Indicators to measure resilience.

- **Public Capital Stressors (or Drivers and Conditions)**. The Climate Stressors and Drivers of Change in the framework are supplemented with more general "Public Capital Stressors". In effect, the "Stressors and Drivers" coincide with "Corporate Stressors" and

"Public Sector Management Stressors". The DRR algorithms introduced in the Technology Assessment 2 tutorial includes specific Hazard Indicators that correspond to these Stressors. Although climate stressors must still be addressed using this framework, the desired measurements involve the positive and negative impacts that private firms and public sector management have on public services, such as the damages caused by climate change-induced disasters, or the inability of communities to effectively respond to changing climatic conditions. In general, climate change is investigated as 1 stock characteristic in "quality of life" scenarios containing several characteristics taken from all of the 7 public capital stocks.

- **Public Capital Stock Services**. The boxes labelled "Economy, Natural Environment, and Infrastructure" on the left hand side of the image are replaced with the more comprehensive 7 Public Capital Stocks used throughout this reference. In addition, the Responses taken to improve those stocks result from changes in the supply of highly demanded stock services, not by the stocks themselves.
- **Public Capital Stock Vulnerabilities and Risks.** The three elements of urban vulnerability, "Exposure, Sensitivity, and Response Capacity", listed on the left hand side, and defined above, are applied in the context of corporate and public sector actions that impact the public services generated by the 7 public capital stocks. The DRR algorithms introduced in the Technology Assessment 2 tutorial includes specific Indicators for measuring Exposure and Sensitivity (called Vulnerability Distribution in that reference). Section B's Overview explains that the third element of Vulnerability Assessment, Response/Adaptive Capacity, can be addressed by carefully defining the use of Condition Indicators (i.e. as their capacity to deliver services) and Action Indicators (i.e. as their capacity to respond effectively to vulnerabilities). Risks can be addressed through Indicator Threshold systems. The impact, or valuation of these services, as defined by multiple stakeholder interests, will be addressed in subsequent sections of this Appendix.
- **Mitigation and Adaptation Actions (or Responses and Impacts), Monitoring and Evaluation, and Institutional Improvement through Adaptive Management**. The bridges, learning loops, Responses, and "Risk Reduction Capacity" in the image support

the "Improves Institutions" component introduced in Section A. Principles, and reinforces the need to monitor and evaluate mitigation actions applied using Adaptive Management until risks to vulnerable public capital stocks are reduced to manageable levels. The DRR algorithms introduced in the Technology Assessment 2 tutorial demonstrate the use of specific Social Fragility and Lack of Resiliency Indicators to reduce risks to vulnerable populations.

- **Sector-specific WBSs**. This framework can be extended beyond urban areas to any area needing to conserve scarce resources. In order to do so, the actual analysis has to be customized for industries and areas (i.e. agriculture and rural). Concretely, this can be done by fully following the guidance presented in the Social Budgeting tutorial for employing sector-specific social networks to administer the WBSs.

D. Indicator Threshold Overview

This section introduces the use of Indicators and Thresholds for measuring the risk and uncertainty associated with assessing public capital stocks and their service flows. Although this applied approach may, over time, prove practical, the use of any accounting framework based on Indicators must be used cautiously. The OECDb (2008), Eurostat (2014), OECD (2015), and EEA (2017) references highlight important conceptual, statistical, and quality control, problems that must be considered when using Indicators to measure the riskiness of outcomes and impacts. An important take home message from those references is that Indicator systems must be tied as closely as possible to real world measurements with real world companies and communities, implying that: 1) Monitoring and Evaluation frameworks that learn from mistakes play a key role in any Resource Conservation Value Accounting Framework (refer to the EEA 2015 and OECD 2015 references); 2) Indicators that can't be qualitatively or quantitatively measured should have limited use, and 3) risk and uncertainty techniques, such as thresholds and sensitivity analysis, must be used with Indicator measurements.

The following images (EPA 2016) demonstrate how resource conservation frameworks use quantitative and qualitative Indicators and Indicator Thresholds to measure climate change-

related risks. That reference explains their use: “threshold values were established for each indicator that defined the upper and lower boundaries of the four resilience categories (i.e. lowest to highest)”. Rather than apply these measurements to specific loss-exceedance events (i.e. 25 year, 50 year, 100 year, 250 year, flood events) they apply them to individual, multi-causal, “gradual changes and/or extreme events” (i.e. prolonged drought, extreme hurricane). The CTAP reference also introduces algorithms (i.e. 11 and 12) that indirectly apply similar techniques.

Table 3. Water sector questions related to drought sensitivity, response, and learning

	Exposure/sensitivity (rs)	Increase response capacity (rc)	Learning related to drought (l)
Water quality	• Are there water bodies at risk from water pollution during drought?	• Are there mechanisms in place to reduce pollution to at-risk streams during drought? • Are there means of enhancing recovery of water quality following drought, and are those methods ready to implement?	• Is there monitoring to assess effectiveness of pollution reduction and recovery strategies and means to incorporate that information into management planning? • Are there any barriers to responding to or learning from drought events past or future drought events?
Groundwater supply	• Is the condition of aquifers and water infrastructure adequate to address long-term drought? • Is the condition of aquifers and water infrastructure adequate to address changes in long-term drought risk (duration, frequency, severity)?	• Are there options available to improve the condition of aquifers and water infrastructure? • Do you have local control of your water source(s) or are they managed by an outside entity (private company, another state, etc.)? • Is resource control centralized or distributed? • Is there a joint institutional mechanism through which water can be managed with partners? • Does the joint institutional partnership provide for flexibility to adjust management in the face of extreme events? • Do water allocation laws (e.g., prior appropriations doctrine) limit control of water	• Is there a mechanism in place to learn from failures to execute drought response plans for water supplies? • Do management entities regularly evaluate management plans? • Have there ever been adjustments made to management practices in response to evaluations of past drought responses? • Does the evaluation include the assessment of potential future climate change stressors? • Does the capacity exist to access and assess monitoring data?

2.2.2. Quantitative Indicator Selection

To organize and obtain detailed data sets that were relevant to urban resilience, the project team created a database of more than 1,400 indicators or metrics derived from the literature on climate change and urban resilience. From this list, specific indicators were selected during meetings with the subcommittees (see example indicator provided in Table 4 and Appendix F for the full list of quantitative indicators).

Table 4. Example question and indicator from urban resilience tool

a. Example question						
Sector	**ID#**	**Question**	**Score = 4 (highest resilience)**	**Score = 3**	**Score = 2**	**Score = 1 (lowest resilience)**
Economy	1	Is the economy of the urban area largely independent, or is it largely dependent on economic activity in other urban areas?	Largely independent	Somewhat independent	Somewhat dependent	Largely dependent
b. Example indicator						
Sector	**ID#**	**Indicator**	**Definition**			**Value**
Economy	1437	Percentage of city area in 500-year floodplain	This indicator reflects the percentage of the metropolitan area that lies within the 500-year floodplain.			11.0%

For each of the quantitative indicators, threshold values were established defining the upper and lower boundaries of the four resilience categories. Initial thresholds were established through a review of published academic literature, panel data, case studies, and other reports, and were

2.3. EXAMPLES OF THRESHOLDS FROM PEER-REVIEWED LITERATURE

Two examples of thresholds found in the literature are Indicator #460 (Macroinvertebrate Index of Biotic Condition) and Indicator #1440 (Drought Severity Index). Thresholds for Indicator #460 are adapted from Weigel et al. (2002). The original five thresholds and the thresholds adapted to reflect a resilience score of 1 to 4 are listed in Table 5.

Table 5. Macroinvertebrate index of biotic condition thresholds

Weigel et al. (2002) thresholds	Adapted thresholds	Resilience score
75 to 80 = Very good biotic condition	Greater than 75 = very good biotic condition	Resilience score = 4
60 to 70 = Good biotic condition	56 to 75 = Good biotic condition	Resilience score = 3
50 to 55 = Fair biotic condition	46 to 55 = Fair biotic condition	Resilience score = 2
25 to 45 = Poor biotic condition	0 to 45 = Poor or very poor biotic condition	Resilience score = 1
0 to 20 = Very poor biotic condition		

The following image (RAND 2016) demonstrates how risk assessment frameworks used by national organizations, such as US NASA, also use Indicator Thresholds to measure project and program risks. The authors explain the use of thresholds as follows: “Requiring that the analysis of each risk factor and its components, indicators, and mitigations begin with an identification of boundaries provides a clear articulation of the limits, acceptable and unacceptable, involved in the analysis. This development process allows senior leaders to articulate boundary conditions upon which a risk is no longer acceptable, providing guidance to the analysis.” Those authors mention that more quantitative risk assessments techniques, such as the probabilistic risk assessments introduced in the CTAP reference, are not appropriate when the probabilities are not known.

Figure 4.5
Detailed Assessment Worksheet for Stability-of-Source Component for Supply Chain

Have a stable and timely supply to the ISS Evaluation: Expert Elicitation/ Historical Data and Evidence Boundary Conditions: _____	Low (0)	Some (1)	Moderate (2)	High (3)	Extremely High (4)	Unacceptable (5)	Weight (User Defined) (0–5)	Score (0–5)	Value (Score X Weight)	Normalized Value (Value/ Total Weight)	Normalized Mitigated Value (Normalized Value/ Total Weight)
R1: Russia markedly raises the cost of service											
R2: Congress does not approve adequate funding for Commercial Crew Program and it gets delayed											
R3 [illegible] ion [illegible] ge											
M1: Find alternative supplier, even if with subsidy.											
M2: Cross-reference with politics node; perhaps make a better case to Congress?											
M3: Use heritage designs as much as possible.											

Risks and mitigations

Threshold values to be filled out using subject-matter experts

Calculation of risk and mitigation

RAND *RR1537-4.5*

The following image (Khazai et al, 2015) demonstrates how risk assessment frameworks used by international organizations also use “Target Levels of Attainment”, or qualitative Indicator Thresholds, to monitor and evaluate progress in reducing risks associated with natural resource disasters. Subagorithm12 in the Technology Assessment 2 reference, demonstrates using this system to compete Disaster Resiliency Indexes.

Table 4.2: Defining Target Levels of Attainment

LEVEL 1	'Little or no awareness' Level 1 represents little or no awareness and understanding of mainstreaming. There is no institutional policy or process for incorporating risk reduction within the functions and operations of the organization. Further, in some cases there is an adverse attitude and adverse institutional culture towards adopting measures to reduce risk. As a result, significant resistance is expected from any risk reduction initiative resulting in greater vulnerability and higher losses in the future.
LEVEL 2	'Awareness of needs' Level 2 refers to an early stage of awareness. The organization has a growing level of awareness, and there is support for disaster reduction among the policy makers. The institution may have activities and dedicated efforts for preparedness but these are simply limited to response. However, support is limited and does not necessarily carry through all levels of the organization; resistance to change is expected at various levels where business as usual is judged sufficient. In general, the institution has no established policy, guidelines or system for mainstreaming, and action will be needed at the highest level to establish such policies and systems. This level is expected not to result in risk reduction in the long term. Vulnerability is expected to increase.
LEVEL 3	"Engagement and Commitment". Level 3 refers to a high level of engagement and commitment to DRR by the institutions. However, the policies and systems have not been fully established yet. The institution may not have a deep understanding of the mainstreaming process and requirements and still has limited capacity, but overall it is willing to make the investments and has already taken some action; commitment for change, and in particular to shift from response only to mainstreaming DRR. There maybe "pockets of resistance" but these are expected to be overcome with time.
LEVEL 4	'Policy Engagement and Solution Development' Level 4 refers to an intermediate stage in mainstreaming, where there is already an established policy for mainstreaming, an overall institutional process/system, and identifiable actions that render the system sustainable and irreversible. In general DRR is seen as an asset by policy makers who are willing to invest in it. The organization is engaged into planning and control processes to address the requirements of integrating risk reduction into its planning and development processes, and in building resiliency in the core services. Processes of coordination and regular drills and exercises have been put in place.
LEVEL 5	'Full integration' Level 5 refers to a situation where risk reduction is fully absorbed into planning and development processes as well as core services. The organization places high importance on reducing disaster risks in a sustainable program of action at multiple levels and within multiple sectors, and there is a comprehensive demonstration of practice. Level 5 describes a situation where disaster risk reduction is 'institutionalized'. However, this is not to suggest that an optimum level of attainment has occurred: there is still a need for further progress. The process of mainstreaming should be viewed as open-ended: while organizations should aim

The following image (EEA, 2017) demonstrates the use of Indicators and Thresholds for assessing the impacts of climate change.

Table 5.8 Most harmful extreme weather phenomena and their threshold values

Phenomenon	1st threshold: harmful impacts are possible, 0.33	2nd threshold: harmful impacts are likely, 0.66	3rd threshold: harmful impacts are certain, 0.99
Wind (gust speed)	≥ 17 m/s	≥ 25 m/s	≥ 32 m/s
Snowfall	≥ 1 cm/day	≥ 10 cm/day	≥ 20 cm/day
Rain	≥ 30 mm/day	≥ 100 mm/day	≥ 150 mm/day
Cold (mean temperature of the day)	< 0 °C	< – 7 °C	< – 20 °C
Heat (mean temperature of the day)	≥ + 25 °C	≥ + 32 °C	≥ + 43 °C
Blizzard	A blizzard is considered to occur when the threshold values of wind, snowfall and cold are realised simultaneously		

Source: Leviäkangas and Saarikivi, 2012.

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The following image (Eurostat, 2014) compares how several national and international government statistical agencies measure Indicators and use Thresholds to define performance for the measurements.

Table 2.1: Comparison of the category 1 methods in use

	Values of the indicator taken into account		Shape of the target path or extrapolation (in brackets: calculation method)	Assessment classes	Thresholds
	First value (reference value)	Last value			
Belgium	Same as Eurostat	Same as Eurostat	Linear (slope)	Three: - 'positive' - 'neutral' - 'negative'	>0.8 (positive) >0.5 and <0.8 (neutral) <0.5 (negative)
Eurostat ([14])	Reference value for the target (e.g. value of the indicator in 2003 for the indicator 'Early leavers from education and training' if the EU target is used)	Last available value of the indicator	Exponential (AAGR)	Four: - 'positive' - 'moderately positive' - 'moderately negative' - 'negative'	>1 (positive) >0.8 and <1 (moderately positive) >0 and <0.8 (moderately negative) <0 (negative)
Germany	Reference value for the target (same as Eurostat) Projection: Value of the indicator five years before the last available value	Last available value of the indicator	Exponential (AAGR)	Four: - 'positive' - 'moderately positive' - 'moderately negative' - 'negative' + Spearman's rank correlation coefficient	>0.95 (positive) >0.8 and <0.95 (moderately positive) >0 and <0.8 (moderately negative) <0 (negative)
Switzerland	Same as Eurostat	Same as Eurostat	Linear (slope)	Three: - 'positive' - 'neutral' - 'negative'	>0.97 (positive) >0 and <0.97 (neutral) <0 (negative)

The NESP Section 3, Using Indicators Effectively (2017) reference provides the following guidelines on how to use Indicator Thresholds to assess the risk and uncertainty about performance.

"Imprecise estimates of performance for one or more measures are typical. A common but undesirable way of dealing with uncertainty about performance is to create measurement scales that lump quantitative results into "bins," such as 0–10 breeding pairs of a particular bird species, 11–20 breeding pairs, and so on. The problem with this tactic is that to unambiguously assign a particular result to the correct bin, i.e, to know that it belongs to the 0–10 bin and not to the 11–20 bin—the evaluator must know whether the number of breeding pairs is 10 or 11.

A better way to handle uncertainty about the number of breeding pairs is to express performance as a range of values in cells of the alternatives/attribute matrix. Instead of describing performance as falling into a predefined "bin," such as 0–10, express performance as a range considered likely to encompass the true performance (e.g., 5–8 breeding pairs) or as a probability distribution (e.g., a mean of 6.5 with a standard deviation of 2). Then carry out the rest of the analysis by using the extremes of the range (or by sampling from the probability distribution) to see if that uncertainty affects the overall rating of alternatives."

Applying these guidelines to the EPA 4 Level Resiliency system, the Low Resiliency Score might establish a realistic benchmark for the current condition of the resource or for a realistic condition that could be described as severely degraded. The High Resiliency Score reflects plausible boundaries for extreme positive conditions away from the benchmark (i.e. upper confidence interval or 3 standard deviations), such as fully sustainable.

E. Social Performance Indicator Threshold Overview

In order to support the Section A principles, "Supports … Resource Allocation Decisions" and "Supports … Materiality Reporting", desired Indicator Thresholds must measure private and public sector investments, services, and assets in terms of costs, benefits, productivity, tradeoffs,

and performance. The following two images (TFCRFD, 2016) demonstrate using a standard set of materiality indicators (i.e. the Financial Impacts to Firms column) to measure risks to private sector firms. These materiality indicators demonstrate the use of the desired cost, benefit, and performance, impact metrics. Although the images highlight Climate-Related Risks and Opportunities, the same materiality indicators are fully applicable to any financial risk faced by a private sector company.

Examples of Climate-Related Risks and Potential Financial Impacts

Type	Climate-Related Risks	Potential Financial Impact
Transition Risks	**Policy and Legal**	
	– Increased pricing of GHG emissions – Enhanced emissions-reporting obligations – Mandates on and regulation of existing products and services – Exposure to litigation	– Increased operating costs (e.g., compliance costs) – Write-offs and early retirement of existing assets due to policy change – Impaired assets – Increased insurance premiums – Fines and judgments
	Technology	
	– Substitution of existing products and services with lower emissions options – Unsuccessful investment in new technologies – Upfront costs to transition to lower emissions technology	– Write-offs and early retirement of existing assets – Reduced demand for products and services – Upfront research and development (R&D) expenditures in new and alternative technologies – Upfront capital investments in technology development – Upfront costs to adopt/deploy new practices and processes[1]
	Markets	
	– Changing customer behavior – Uncertainty in market signals – Increased cost of raw materials	– Reduced demand for goods and services due to shift in consumer preferences – Increased production costs due to changing input prices (e.g., energy, water) and output requirements (e.g., waste treatment) – Abrupt and unexpected shifts in energy costs – Changing revenue mix and sources Re-pricing of assets and speed of re-pricing (e.g., fossil fuel reserves, land valuations, securities valuations)
	Reputation	
	– Shift in consumer preferences – Stigmatization of sector – Increased stakeholder concern or negative stakeholder feedback	– Reduced demand for goods/services – Reduction or disruption in production capacity (e.g., shutdowns, delayed planning approvals, interruptions to supply chain) – Impacts on workforce management and planning (e.g., employee attraction and retention) – Reduction in capital availability
Physical Risks	**Acute**	– Reduction or disruption in production capacity (e.g., shutdowns, transport difficulties, supply chain interruptions) – Impacts to workforce management and planning (e.g., health,safety, absenteeism) – Write-offs and early retirement of existing assets (e.g., damage to property and assets in "high-risk" locations) – Increased operating costs (e.g., inadequate water supply for hydroelectric plants or to cool nuclear and fossil fuel plants) – Increased capital costs (e.g., damage to facilities) – Reduced revenues from lower sales/output – Increased insurance premiums and potential for reduced availability of insurance on assets in "high-risk" locations
	– Increased severity of extreme weather events such as cyclones and floods	
	Chronic	
	– Changes in precipitation patterns and extreme variability in weather patterns – Rising mean temperatures – Rising sea levels	

Table 2

Examples of Climate-Related Opportunities and Potential Financial Impacts

Type	Climate-Related Risks	Potential Financial Impact
Resource Efficiency	– Use of more efficient modes of transport – More efficient production and distribution processes – Use of recycling – More efficient buildings – Reduced water usage and consumption	– Reduced operational costs (e.g., through efficiency gains and cost reductions) – Increased production capacity – Increased value of fixed assets (e.g., highly rated energy-efficient buildings) – Benefits to workforce management and planning (e.g., improved health and safety, employee satisfaction) – Better prepared for changes in or additions to government policies and regulations
Energy Source	– Lower-emission sources of energy – Supportive policy incentives – Emergence of new technologies – Participating in carbon market – Energy security and shift toward decentralization	– Reduced operational costs (e.g., through use of lowest cost abatement) – Reduced exposure to future energy price increases – Reduced exposure to GHG emissions and therefore less sensitivity to changes in cost of carbon – Generate return on investment in low-emission technology – Increase in capital availability (e.g., as more investors favor lower-emissions producers) – Reputational benefits and increased demand for goods/services
Products and Services	– Develop and/or expand low emission goods and services – Climate adaptation and insurance risk solutions – R&D and innovation – Diversify business activities – Shifting consumer preferences	– Increased revenue through demand for lower emissions products and services – Increased revenue through new solutions to adaptation needs (e.g., insurance risk transfer products and services) – Increased resilience to changes in government policies and regulations – Better competitive position to reflect shifting consumer preferences
Markets	– New markets – Public-sector incentives – Community needs and initiatives – Development banks	– Increased access to new and emerging markets (e.g., partnerships with governments, development banks) – Increased diversification (e.g., green bonds and infrastructure) – Increased resilience in existing supply chain relationships – Increased demand for goods/services in new markets
Resilience	– Participate in renewable energy programs and adopt energy-efficiency measures – Resource substitutes/diversification – New assets and locations needing insurance coverage	– Increased market valuation through resilience planning (e.g., infrastructure, land, buildings) – Increased reliability of supply chain and ability to operate under various conditions – Increased revenue through new products and services related to ensuring resiliency

The following image (Hammerl, 2016) demonstrates a similar set of private sector risks, and similar surmised materiality indicators, associated with ecosystems and biodiversity. The authors cite recent surveys that have found that "more than three quarters of Europeans [i.e. consumers]

believe that mankind has a responsibility to look after nature and that it is important to stop biodiversity loss." Recent surveys in the US confirm that 64% of US citizens [i.e. consumers] have similar sentiments about dangers they face from climate change (http://www.gallup.com, March 2017 poll). Protest marches held throughout the world in 2017 confirm that many citizens (i.e. consumers) feel the same way about potential losses to institutional, social, and human capital stock services, including gender and civil rights.

Examples of direct and commercial risks resulting from a loss of biodiversity and a reduced functionality of ecosystems	
Operational risks	• Limited availability of plant- and animal-based resources • Limited availability of ecosystem-based production factors, such as clean water and fertile soils • Price increases for natural resources as a result of shortages • Lack of innovation – biological systems and the functional principles of nature act as drivers for businesses' new products and processes (bionics) • Decreased attractiveness for tourism destination and negative impact on tourism business
Risks of reputation loss	• Damage to the image of industries or individual businesses due to the negative effects of economic activities on biodiversity • Damage to the image of a specific location that can also affect the image of the products and services produced
Market-related risks	• Changes in buying behaviour (end consumer, business to business), with a stronger emphasis on biodiversity criteria • Failure to penetrate new markets
Regulation-and law-related risks	• Regulations governing the acquisition and use of natural resources, such as fishing quotas; emission limit values, taxation of resources • Regulations governing access to and the use of genetic resources (access and benefit sharing), the implementation of the Nagoya Protocol in national legislation • Regulations governing interventions in nature, such as compensatory payments/actions • Restricted access to species-rich (conservation) areas, e.g. prohibition of mining in conservation areas
Liability risks	• Lawsuits against industries or businesses for causing the loss of biodiversity, for example under the EU Environmental Liability Directive
Financial market risks	• Consideration of biodiversity criteria when financial institutions grant credit and make investments • Biodiversity as an assessment criterion in sustainability ratings

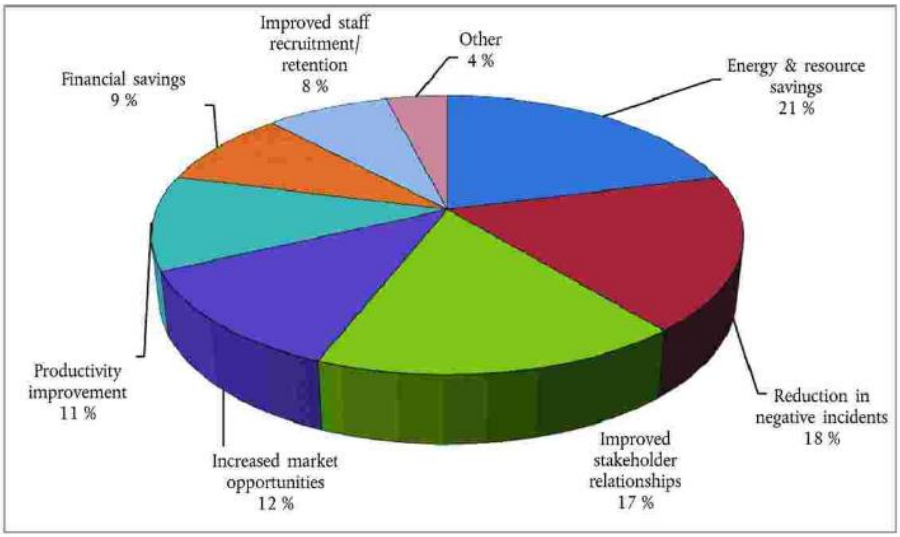
Although these materiality indicators highlight the specific impacts on a firm's financial "gross performance", they must be further defined in terms of productivity (i.e. input per unit output), efficiency (i.e. movement along the scale of benefit and cost Indicator Thresholds that can act as a proxy for marginal benefits and costs) performance (i.e. quantity of inputs consumed as percent total inputs available for consumption) and tradeoffs (i.e. quality of service 1 can be increased but quantity of service 2 must be reduced). Examples include (i.e. also see Section 2.3.2.4 of EMAS 2017):

- **Capital Investment Budget Indicator**: Threshold 1 = 1% capital investment budget; Threshold 2 = 10% capital investment budget; Threshold 7 = 100% capital investment budget.
- **Cost per unit Emission Reduction Indicator**: Threshold 1 = 1% of operating costs per unit emission reduction; Threshold 2 = 10% of operating costs per unit emission reduction; Threshold 7 = 100% of operating costs per unit emission reduction.
- **Input as Percent Total Available Capacity**: Threshold 1 = 50 m3 water consumed per 1,000 m3 water available; Threshold 2 = 25 m3 water consumed per 1,000 m3 water available; Threshold 7 = 5 m3 water consumed per 1,000 m3 water available.
- **Emission per Unit Output Indicator**: Threshold 1 = 1% of emission standard; Threshold 2 = 10% emission standard; Threshold 7 = 100% emission standard.
- **Targeted Customer 1 ESG Satisfaction Index**: Threshold 1 = 1% of target index; Threshold 2 = 10% target index; Threshold 7 = 125% target index.

The following image (EMAS, 2017) documents the benefits that European companies have experienced from adopting similar types of financial reporting systems.

Figure 1

Benefits of implementing EMAS (% all responses)



Given that the public sector also makes capital investments, collects annual revenues, incurs operating costs, manages workforces, owns assets with market values, and strives to deliver services using more productive business practices, a similar set of materiality impact indicators can be adapted to measure Social Risks to Communities. The major difference is to account for the public sector's primary responsibility for increasing the public's returns from the services generated from public goods. As the USDOI (2015) puts it "[federal] investments should maximize the present value of net public benefits".

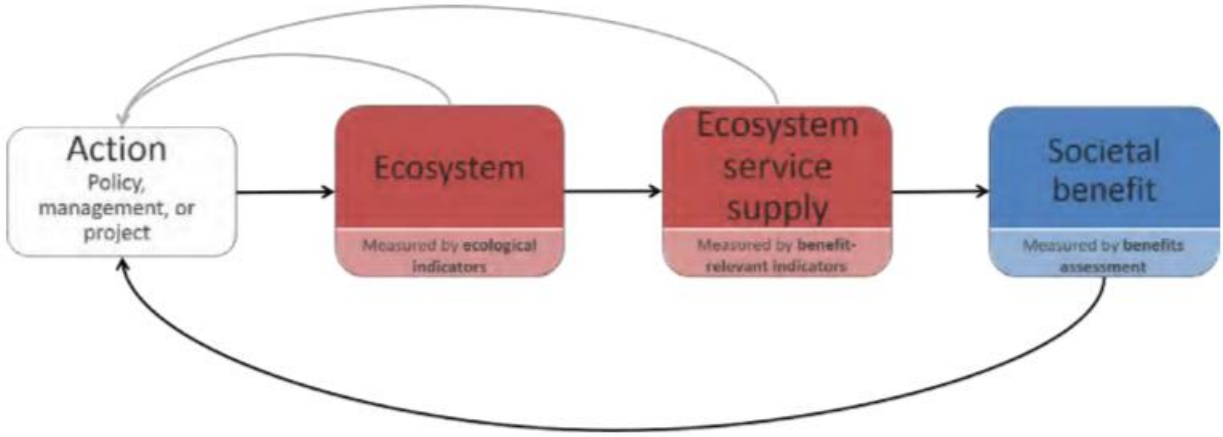
In the context of the ecosystem services generated by natural resources capital stocks, PR&G (2014) defines public benefits and costs as "Ecosystems provide services to people. Thus, Federal investment impacts on the environment or ecosystem may be understood in terms of changes in service flows. The process of identifying, evaluating, and comparing these changes provides a useful organizing framework to produce a complete accounting [i.e. this RCA Framework]. Reduced service flows over time amount to costs, and increased services flows over time amount to benefits."

The following definition and image (NESP, Section 3, 2017) demonstrate the use Benefit-Relevant Indicators and of Causal Chains for measuring the public returns, or benefits, generated by public services (i.e. in this case, the ecosystem services generated by natural resources capital stocks). The same principles hold for any public service generated by any public capital stock. Note that the "performance objective" mentioned in the image's caption coincide with the expected performance of Mitigation and Adaptation Actions that are applied in this RCA Framework. This reference uses the terms "causal chains", "social impact pathways", "results chains", "exposure pathways", and "theory of change" interchangeably (i.e. the Indicators change depending on the term and the purpose of the assessment).

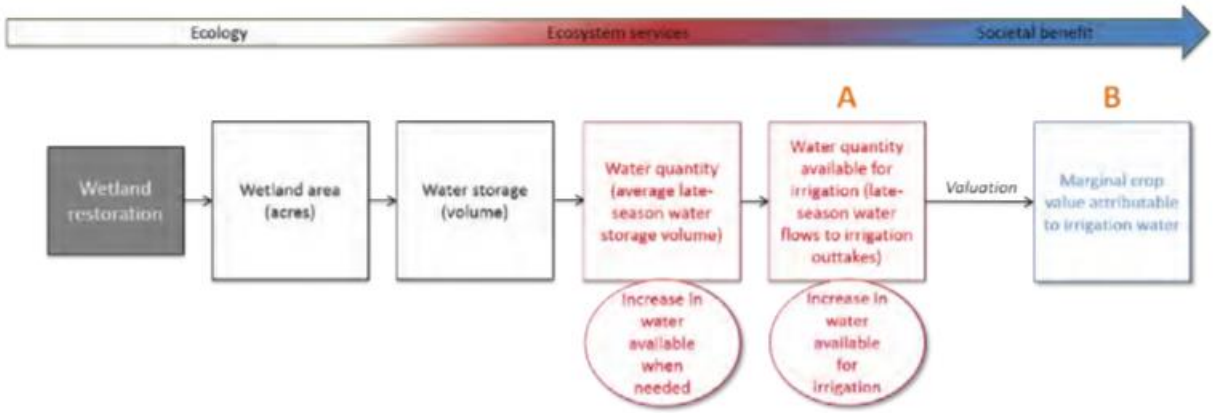
"Benefit-relevant indicators (BRIs) are measurable indicators that capture this connection by considering whether there is demand for the service, how much it is used (for use values) or enjoyed/valued (for nonuse values), and whether the site provides the access necessary for people to benefit from the service, among other considerations. An ecological measure can become a BRI if it is tied directly and causally to something important to people, e.g., the presence of bald eagles, which are clearly identified as important to the American public."

Figure 3. Example causal chains

(a) Components of an ecosystem service causal chain



(b) Example of an ecosystem services causal chain for wetland restoration and water availability for crops



The process of creating causal chains and conceptual diagrams evolves during the analytical process. It may start conceptually, but then indicators are added to make the concepts measureable, followed by the insertion of data, and ultimately it can become the template for a data-driven model used to estimate changes in services expected from a policy or management action (Figure 3b). The indicators identified in the causal chains can be used to monitor changes or assess performance against an objective (e.g., performance metrics).

Importantly, the UN-SETAC (2016) reference in Appendix C, Example 3, refers to this type of Indicator valuation technique as being based on "instrumentally valued systems" that derive their benefits from their utility to humans. In contrast, "intrinsically valued systems" derive Indicator benefits from their existence. "Culturally valued systems" derive value to humans based on aesthetic, artistic, recreational, or spiritual, qualities.

For example, the following image shows how some international organizations (IPBES, 2016a) relate ecosystem services to human benefits based on instrumental, intrinsic, and cultural values. Note the implied, overall, performance objective of public services – improve human quality of life.

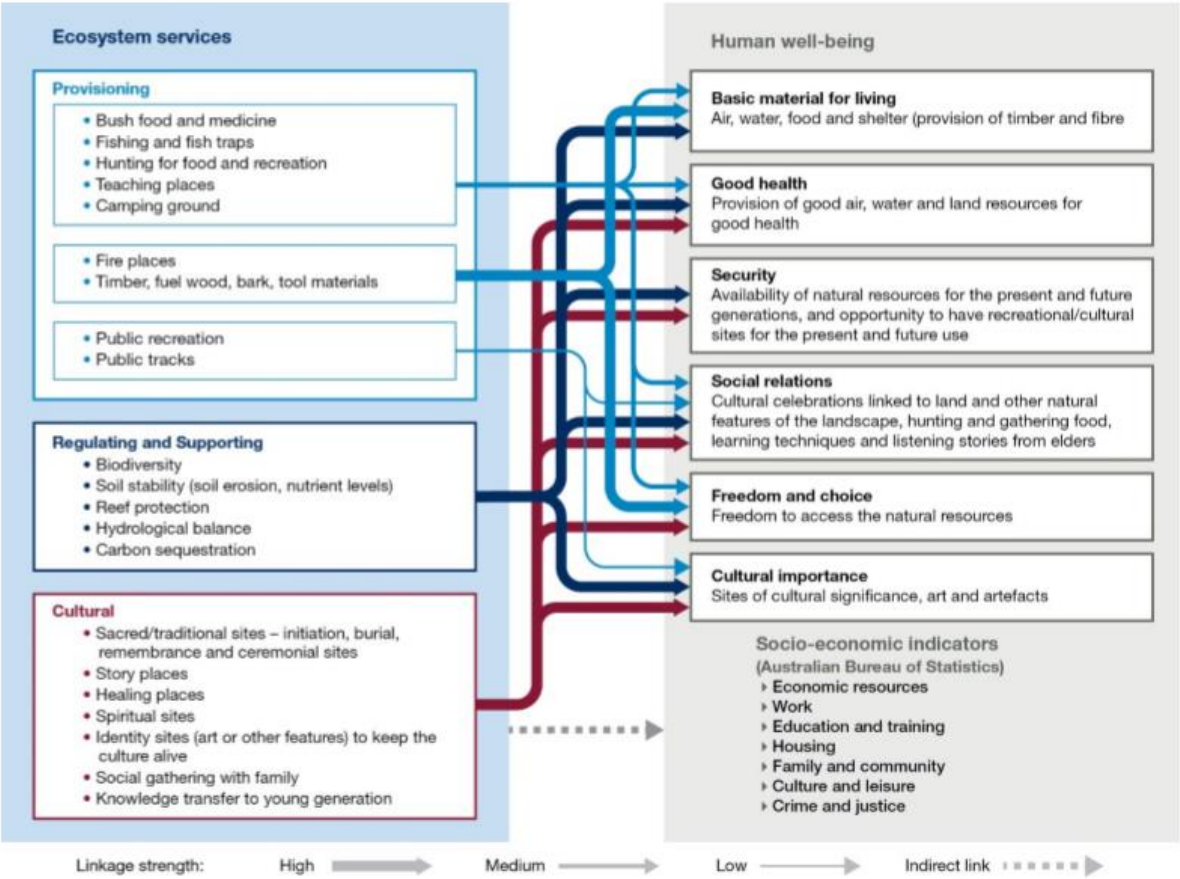


Figure 7.6: Relationships between ecosystem services and the constituents of well-being identified by the Mullunburra-Yidinji community, north Queensland (Modified from Sangha et al., 2011, David Publishing Company). Links between each ecosystem service and well-being are highlighted to demonstrate the importance of ecosystem services in terms of the well-being of indigenous peoples, and which indicators of well-being could be incorporated into the development of biodiversity and ecosystem services scenarios and models.

The 1st of the following 3 images (Santos-Martín, 2016) demonstrates the use of ecosystem valuation methods to measure the benefits arising from these provisioning, regulating/supporting, and cultural, ecosystem services. The 2nd and 3rd images illustrate the meta-analysis results derived from a review of those valuation techniques carried out throughout all of Spain. This

reference provides good conceptual overviews of how these different valuation methods can be used to value ecosystem services. The IBPES (2016) references cover alternative valuation methods in depth.

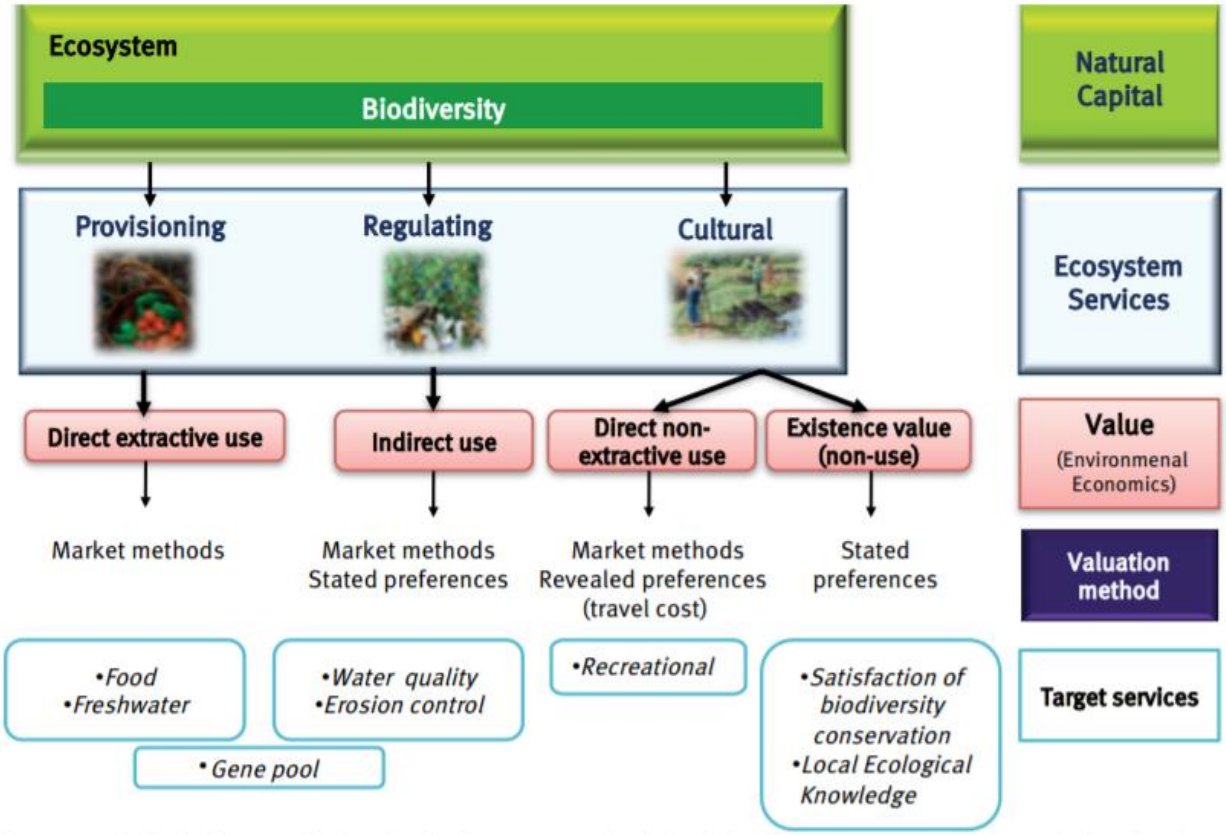


Figure 3. Methodological map used in the valuation of ecosystem services in Spain, in which one can see the different typologies of services derived from natural capital, and the different types of associated value according to the framework of Environmental Economy. Finally, the most appropriate methodologies for each case are presented for each case, and in blue one can see the services that have been assessed in the project, combining the use of these methodologies (we do not include the services assessed with meta-analysis techniques as they include different techniques).

Table 3. Average economic value of the methods of valuation and the categories of services of the ecosystems expressed in €2012/year /ha; S.D: Standard deviation

	N	Average economic value (€2012/year /ha)	SD
Categories of services of the ecosystems			
Provisioning	59	284.04	499.47
Regulating	152	131.40	347.31
Cultural	222	100.83	280.04
Kruskall-Wallis	6.10*		
Methods of valuation			
Market	42	455.95	531.47
Revealed preferences	65	106.31	274.97
Stated preferences	289	101.89	309.52
Cost	37	97.56	280.27

Table 4. Summary of the monetary values for each ecosystem service (values in €/ha/year, 2012).

	N	Average value (€2012/year /ha)	SD	Minimum value (€2012/ year /ha)	Maximum value (€2012/ year /ha)
Provisioning services					
Food	38	371.04	582.50	0.000052	1972.65
Regulating services					
Regulation of natural disturbances	13	262.83	435.38	1.99	1364.45
Climate regulation	16	181.35	194.31	0.0023	528.44
Water purification	48	135.31	436.34	0.01	1970.31
Erosion control	29	31.99	44.29	0.87	234.72
Biological control	21	15.43	18.17	0.15	56.30
Cultural services					
Recreational and ecotourism activities	117	186.36	364.07	0.44	1836.90
Aesthetic enjoyment of landscapes	47	84.84	372.99	0.41	1871.99
Satisfaction with conservation	42	6.26	16.29	0.12	100.03

Although the Spanish study highlights the advantages to documenting the monetary benefits associated with ecosystem services, most of the comprehensive references used in this Appendix (i.e. IPBES, EEA, OECD, IPCC, USEPA, and USGCRP) discuss the importance of using a mix

of quantitative and qualitative measures of performance in assessing the value of public services. For example, OECD (2015) describes this mix in the following statement.

"[Climate change adaptation indicator sets] may entail a mix of qualitative outcome indicators and quantitative process indicators. On their own, any category of indicator may not be enough. For instance, a [quantitative] process indicator specifying whether a policy framework has been developed does not shed light on whether the policy has been implemented and what the corresponding outcomes are. It is useful to complement this type of indicator with qualitative indicators to assess how the policy may have contributed to changes observed."

In the context of Monitoring, Reporting, and Evaluation (MRE, or M&E) indicator systems, the EEA (2015) describes this mix in the following statement. The EPA Indicator Threshold system displayed throughout this Appendix is an example of a "mixed methods" approach.

"A mixed methods approach to MRE makes use of multiple sources of information and combines both the quantitative and qualitative methods (for example using a range of indicators, alongside stakeholder perspectives gained through self-assessments, surveys and consultations with experts). This allows for more effective triangulation of information gathered through MRE processes as different data sources can be checked against each other to ensure that the overall narrative of adaptation progress is robust, consistent and contextualised."

In the context of this RCA Framework, IITA and COSA (2016 in Appendix C, Example 1) explain the relation between "results chains", "causal chains", "theory of change", or "social impact pathways", and mixed methods assessment techniques:

"Explanatory mixed methods use a structured qualitative investigation to determine if a chain of causation, consistent with the theory of change [or social impact pathway], was implemented and could have plausibly explained changes in performance pointed to by the quantitative evidence."

Social scientists, business managers, public sector analysts, and financial accountants have spent decades developing similar Indicators and Indicator Threshold systems for measuring costs, benefits, productivity, tradeoffs, and performance. The following image (EPA, 2016) demonstrates the use of Indicator Thresholds for socioeconomic variables, which include Social Risks. In this example, several of these indicators measure input use productivity, such as energy consumption per capita or BTU use per dollar.

Thresholds

		Thresholds			
Indicator ID#	**Indicator Name**	**Score 1 (lowest resilience)**	**Score 2**	**Score 3**	**Score 4 (highest resilience)**
i.	**Economy**				
709	Percentage of owned housing units that are affordable	0 to 30%	Greater than 30 to 45%	Greater than 45 to 60%	Greater than 60%
711	Overall unemployment rate	0 to Less than 83%	83 to Less than 91%	91 to Less than 100%	100%
717	Percent access to health insurance of non-institutionalized population	Less than 85%	85 to 90%	Greater than 90 to 95%	Greater than 95%
722	Percent change in homeless population	Greater than 10%	Greater than 0 to 10%	Greater than negative 10 to 0%	Less than negative 10%
1375	Percent of population living below the poverty line	Greater than 20%	Greater than 16 to 20%	12 to 16%	Less than 12%
ii.	**Energy**				
898	Annual energy consumption per capita by main use category (commercial use)	Greater than 4.0 tons of oil equivalent	Greater than 3.0 to 4.0 tons of oil equivalent	Greater than 2.0 to 3.0 tons of oil equivalent	Less than or equal to 2.0 tons of oil equivalent
924	Energy intensity by use	Greater than 3,000 Btu per dollar	Greater than 2,000 to 3,000Btu per dollar	Greater than 1,500 to 2,000 Btu per dollar	Less than 1,500 Btu per dollar
949	Percent energy consumed for electricity	N/A	N/A	N/A	N/A
950	Percent of electricity generation from non-carbon sources	Less than 25%	25 to 50%	Greater than 50 to 75%	Greater than 75%
951	Percent of total energy use from renewable sources	Less than 20%	20 to 40%	Greater than 40 to 60%	Greater than 60%
967	Total energy source capacity per capita	Less than 1.0 megawatt per capita	1.0 to 2.0 megawatt per capita	Greater than 2.0 to 5.0 megawatt per capita	Greater than 5.0 megawatt per capita

The following images (EEA, 2017) demonstrate the use of Indicator Thresholds for socioeconomic variables which include ecosystem services and materiality impacts (top image) and socioeconomic scenarios (bottom image). In relation to this RCA Framework, the top

image's Level 1 = Stressors, Level 2 = Threshold levels, Level 3 = Ecosystem services, and Level 4 = Impacts/sensitivities. The second image includes social science scenarios, specifically SS3 and SS4, which have become more pronounced, and worrisome, in some countries in recent years.

Table 6.6 Vulnerability of ecosystem services in the Mediterranean

Sector	Ecosystem services	Stress (climate, others)	Impacts/ sensitivities	Critical thresholds for ecosystem services
Agriculture, grazing, agroforestry	Food (crop and livestock) production	• Higher temperatures • Changing precipitation patterns • Water stress • Disease • Erosion • Urban encroachment	• Higher irrigation demand • Reduced productivity • Crop failure • Livestock mortality	• Precipitation threshold beyond which rain-fed systems fail • Fallow groundwater level threshold below which pumping fails
Agriculture	Carbon sequestration	• Higher temperatures • Changing precipitation patterns • Water stress • Disease • Erosion • Urban encroachment	• Higher irrigation demand • Reduced productivity • Soil organic matter decomposition	• Precipitation threshold beyond which rain-fed systems fail • Irrigation water allocations below which permanent cultures die • Fallow groundwater level threshold below which irrigation water pumping fails • Grazing pressure beyond stocking capacity above which productivity sharply declines • Climatic or land-use change threshold beyond which systems turn into carbon sources
Agriculture, forestry	Biofuels, carbon offset	• Higher temperatures • Changing precipitation	• Reduced productivity • Crop or tree mortality	• Precipitation threshold below which biofuels can no

Table 1.6 Summary of assumptions of SSPs for selected variables

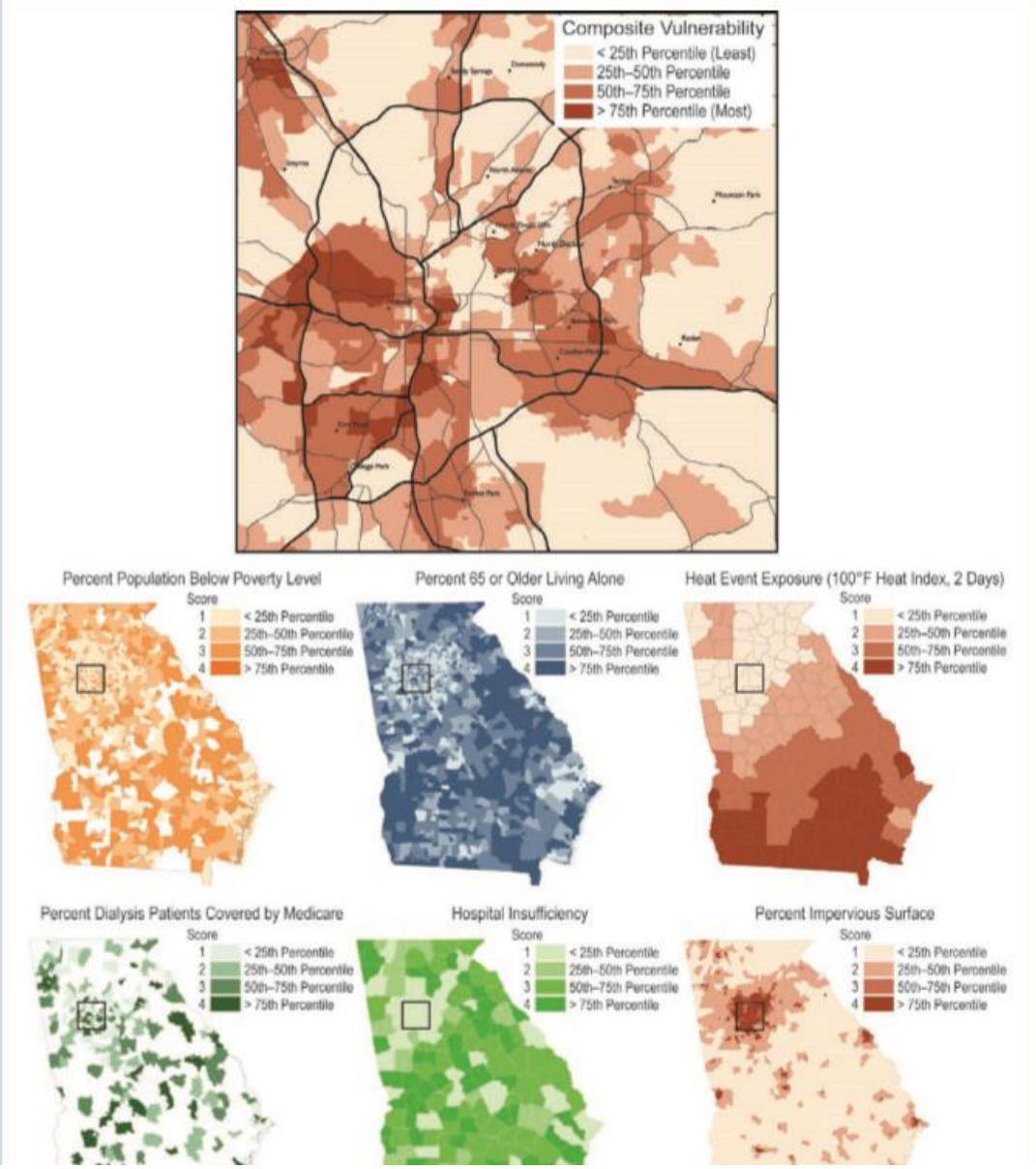
	SSP1	SSP2	SSP3	SSP4	SSP5
Main objective	Global sustainability	Not defined	National security	Security	Economic growth
Population growth	Relatively low	Medium	High/low (*)	Relatively high/low (*)	Relatively low
Urbanisation	High	Medium	Low	High/medium (*)	High
Education level	High	Medium	Low	Low/medium (*)	High
Equity	High	Medium	Low	Medium	High
Economic growth	High/medium (*)	Medium, uneven	Slow	Low/medium (*)	High
International cooperation	Effective	Relatively weak	Weak, uneven	Effective (for small elite only)	Effective (but no environmental focus)
Institutions	Effective (all levels)	Uneven, modest effectiveness	Weak (global), strong (national)	Effective (for small elite only)	Effective (focus competitiveness)
Technological development	Rapid	Medium, uneven	Slow	Rapid (high-tech sectors only)	Rapid
Carbon intensity	Low	Medium	High (regions with large domestic resources	Low/medium (*)	High
Environment	Improving conditions	Continued degradation	Serious degradation	Degrading/ highly managed (*)	Highly engineered
SRES	B1 (A1T)	B2	(A2)	A2	A1FI

Note: (*) The information to the left of the slash refers to high-fertility countries (i.e. mostly developing countries) and the information to the right of the slash refers to rich Organisation for Economic Co-operation and Development (OECD) countries (KC and Lutz, 2015).

The bottom row with information on 'matching' SRES scenarios is only indicative, and some 'matches' are closer than others.

The following image (USGCRP, 2016) uses geographic vulnerability mapping to develop a Composite Heat Vulnerability Index that identifies communities vulnerable to heat waves. The authors describe the public sector performance advantages offered by this technique as follows: “By linking together census data, data on the determinants of health (social, environmental, preexisting health conditions), measures of adaptive capacity (such as health care access), and climate data, GIS mapping helps identify and position resources for at-risk populations”. In this example, public sector performance is enhanced by using the Indicator, Vulnerability Index, to target where public funding should be directed. In the context of Social Performance measurement, the authors mention that these approaches have been extended to measure the actual health outcomes associated with the public expenditures.

Mapping Heat Vulnerability in Georgia



The USGCRP (2016) authors use the following image to demonstrate the modeled relationship (i.e. a dose-response mathematical relation) between urban deaths and temperature increases.

Continuing with the Georgia heat stress example, a logical extension of this technique is to develop Indicator Thresholds that define cost, benefit, productivity, tradeoffs, and performance levels for reducing the risks of increased deaths from increased temperatures, as illustrated in Section B. Implementation Steps, Community Example 1 (i.e. High Resiliency Score = per capita cost to reduce 90% deaths from 1.5 degree temperature increase = $1, Low Resiliency Score = per capita cost to reduce 100% deaths from 1.5 degree temperature increase = $1 million).

Projected Changes in Deaths in U.S. Cities by Season

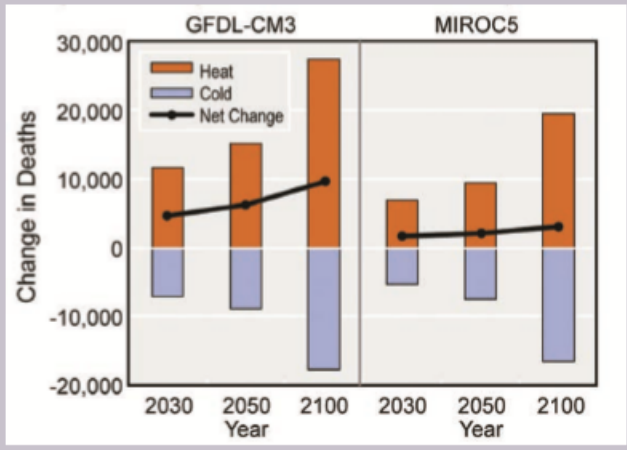


Figure 4: This figure shows the projected increase in deaths due to warming in the summer months (hot season, April–September), the projected decrease in deaths due to warming in the winter months (cold season, October–March), and the projected net change in deaths for the 209 U.S. cities examined. These results compare projected deaths for future reporting years to results for the year 1990 while holding the population constant at 2010 levels and without any quantitative adjustment for potential future adaptation, so that temperature–death relationships observed in the last decade of the available data (1997–2006) are assumed to remain unchanged in projections over the 21st century.
With these assumptions, the figure shows an increasing health benefit in terms of reduced deaths during the cold season (October–March) over the 21st century from warming temperatures, while deaths during the hot season (April–September) increase. Overall, the additional deaths from the warming in the hot season exceed the reduction in deaths during the cold season, resulting in a net increase in deaths attributable to temperature over time as a result of climate change. The baseline and future reporting years are based on 30-year periods where possible, with the exception of 2100: 1990 (1976–2005), 2030 (2016–2045), 2050 (2036–2065), and 2100 (2086–2100). (Figure source: adapted from Schwartz et al. 2015)[27]

The desired outcome from the applied use of this framework is for private companies and public entities to comply with consistent resource conservation accounting frameworks, standards, indicator threshold systems, risk and uncertainty measurements, time horizons, reporting requirements, and effective risk reduction actions (i.e. the KPMG advice (2016) to “align and harmonize” these Indicator systems). The social risks of bad actor behavior, such as air pollution costs caused by managing emissions badly, are measured and reported using the same set of metrics, whether the bad actor is a local government utility, corrupt politician, or local factory.

F. Indicator Thresholds and Work Breakdown Structure

The following stylized Private and Public Performance Indicator Threshold tables illustrate how each of the WBS Risks might be measured. Section C's tools introduce the actual TEXT datasets used to apply this framework. The same materiality indicators are used in both systems, but the threshold levels differ, with the focus switching from private sector risks in the top table to public sector risks in the bottom table. The generic indicators shown in the Indicator Threshold tables are refined by social networks when applied to the specific risks listed in this WBS for companies and communities. For example, rather than using the generic indicator, cost per unit output, a refined indicator might be 'per capita cost per unit renewable energy production'.

Private Performance Risk Indicator Thresholds					
Label	**Indicator**	**Score = 4 (highest resilience)**	**Score = 3**	**Score = 2**	**Score = 1 (lowest resilience)**
I1	integration into financial reporting systems	100% integrated into performance system	< 75% integrated	< 50% integrated	<25% integrated
I3	increase in compliance costs	0.25% gross revenues	>2x	>5x	>10x
I4	increased operating costs				
I5	increased capital costs				
I6	decreased revenues				
I7	writeoffs and early retirement of assets				
I8	impaired assets				
I9	increased insurance premiums				
I10	reduced demand for products and services				
I11	increased fines and judgements				
I12	increased investment in new technologies and new R&D				
I13	reduction in production capacity				
I14	decreased employee retention				
I15	increased access to new markets				
I16	increased diversification of products and sources of revenue				
I17	increased market valuation				
I18	cost per unit output				
I19	cost per dollar output				
I20	input per unit output				
I21	output per unit input				

Public Performance Risk Indicator Thresholds					
Label	**Indicator**	**Score = 4 (highest resilience)**	**Score = 3**	**Score = 2**	**Score = 1 (lowest resilience)**
I1	integration into financial reporting systems	100% integrated into performance system	< 50% integrated	< 25% integrated	<5% integrated
I3	increase in compliance costs	0.25% gross revenues	>2x	>5x	>10x
...	...				

The following WBS illustrates typical Social and Private Risk and Indicator elements used in this Framework. This WBS illustrates how tradeoffs between public sector-related disclosures and private company-related disclosures can be understood and applied more easily. The WBS helps public entities and private companies to work in tandem to use their knowledge of risks and tradeoffs to advance each other's goals. This WBS can be downloaded from the Performance Analysis tutorial, but refer to Footnote 11.

Public and Private Performance Risk Tradeoff WBS. January 31, 2017. (subject to completion by sector-specific social networks)								
Capital Stock				Risks		Social Indicators for Public Sector Risks		Private Indicators for Private Sector Risks
A.	**Institutional**					(All indicators are measured relative to benchmark standards)		
	1	**Laws, Regulations and Policies**						
			A	Formulating, Implementing and Retiring	S1	percent change in funds paid out to lobbyists	P1	percent change in compliance costs
			B	Enforcement	S2	percent change in gratuity budget; amount spent on corrupt business practices;	P2	percent change in employee compliance time
	2	**Social Norms and Shared Beliefs**						
			A	Socially Beneficial	S1	change in self regulatory business practices that "foster a relationship of confidence and mutual trust" with communities.	P1	change in self regulatory business practices that "foster a relationship of confidence and mutual trust" with employees, customers, and suppliers.
			B	Socially Harmful	S2	change in funds spent by corporations advocating/challenging (i.e. carbon-intensive energy	P2	percent change in business climate from failure to change
	3	**Incentives, Fines, and Penalties**						
			A	Compliance		percent change in revenues from failure to comply or increased compliance		percent change in costs from compliance
			B	Rent Seeking		percent change in funds paid out to lobbyists		percent change in government sources of revenues
	4	**Response to Intended versus Actual Consequences**						
			A	Performance Reporting		percent integration of transparent performance and M&E accounting systems		percent integration of transparent performance and M&E accounting systems
			B	Adaptive Learning		degree of assistance or resistance adopting adaptive learning mechanisms		degree of assistance or resistance adopting adaptive learning mechanisms
	5	**Political Environment**						
			A	Voter Rights		Influence in voter registration and balloting		change in campaign contribution laws
			B	Demographic Trends		Influence in political district boundaries		change in ability to hire skilled foreign workers
B.	**Economic**							
	1	**Intellectual Property**						
			A	Intellectual Property Rights		change in number of open access media outlets; change consumer protection from restrictive patents,		change in protection for patents, trademarks, and copyrights
			B	Investment in R&D		amount of funds spent per capita		change in ROI for investment in R&D
	2	**Employee Rights and Industrial Relations**						
			A	Wages		change in employee standard of living		change in wage costs
			B	Employee Rights		percent erosion/increase in employee rights including nondiscrimination		change in employee lawsuits
	3	**Consumer Rights and Markets**						
			A	Consumer Rights		change in consumer rights including safety standards, complaint handling, and privacy		change in ability to merge and acquire companies
			B	Supply, Demand, Substitutes and Complements		change in anti-competitive practices, including price fixing, rigged contracts, and output market collusion		change in price control mechanisms
	4	**Corporate Governance and Accountability**						
			A	Corporate and Executive Accountability		change in policies and rules that enforce executive accountability		change in punitive penalties for malfeasance
			B	Financial Reporting		percent integration into financial reporting systems		percent integration into financial reporting systems
	5	**Technological Change and Fit**						
			A	Functional and Economic Obsolescence		change in employment due to increase/decrease in new investment		change in revenue due to increase/decrease in new investment
			B	Technology Adoption		degree of technological appropriateness		degree of new technology adoption
C.	**Natural Resources**							
	1	**Soil**						
			A	Soil Resources		change in soil resource stock		adoption of soil conservation technologies
			B	Soil Quality		change in soil resource stock quality		adoption of soil quality conservation technologies
	2	**Air and Climate**						
			A	Air Resources		change in climate change related disasters		reduction GHG; adoption of climate change mitigation technologies

The KPMG (2016) reference points out that the majority of international mandatory reporting requirements are coming from governments. These mandatory reports provide logical starting places for defining additional WBS Risks, Indicators and Thresholds. For example, Appendix 3 in the TFCRFD, 2016 reference (see the Select Disclosures - Governments image in Section B), shows that Australia requires that corporations report compliance with specific thresholds for GHG emissions.

The EEA (2017) points out the importance of developing Indicator systems that have widespread acceptance, similar to a WBS, so that comparisons can be made between countries, industries, and companies. As an example of the importance of such indicators, they cite the UN's (2016) development of a uniform set of Disaster Risk Reduction (DRR) Indicators that member countries have agreed to use for reporting the results of disasters. Many of those Indicators relate directly to private sector materiality indicators, such as economic losses associated with property, employee, and business disruption. The next section of this Appendix, Public and Private Service Damage and Loss from Disasters, further discusses the role of climate change-related disaster risk information in public and private sector financial reporting and risk management.

The KPMG (2016) reference also points out the UN's Sustainability Development Goals (SDGs) (UNSD, 2016) contain a specific target (12.6) for private sector companies to integrate sustainability [Indicators] into their reporting cycles. The social and economic development nature of those goals mean that the SDG Indicators, as well as the Sendai DRR Indicators, are, in effect, materiality Indicators. Although targeted towards developing countries, many of those goals and Indicators, such as the targets for poverty reduction, can be adjusted to apply to most public sector governments. In addition, many of these targets, such as the targets for environmental improvement, can be adjusted to apply to most private sector companies. Given the large number of reporting instruments found throughout the world (and throughout the references), KPMG (2016) recommends: "Alignment and harmonization must be a key goal for governments, market regulators, stock exchanges, industry associations, standard setters and all those responsible for developing reporting instruments."

This RCA WBS demonstrates how to refine Indicators, such as the SDGs, so that they can be applied, or "aligned and harmonized", for both public and private sector reporting. Appendices B and C will demonstrate "reporting instruments" that integrate widely accepted Indicator systems, such as the UN's SDGs and climate change-related Sendai DRR Indicators, into this framework's WBS, tools, and reports.

The following image (USGCRP, 2016) presents a concrete example of how several of the capitals used in this WBS interact and are applied in resource conservation assessment tools. In the context of this reference, the image's "Climate Drivers" are replaced by "Corporate and Public Entity Drivers [that impact public capital stocks]". The outcome, Improved Physical Health, is replaced by the more general "Improved Quality of Life". Unlike the USGCRP Health Outcome Indicators, appropriate Social Performance Indicators for this RCA Framework must relate more transparently to benefit and cost metrics for impacts to human capital stocks, such as Cost per Quality Adjusted Life Years (QALYs) and Change in Disability Adjusted Life Years (DALYs) Per Change in Stock Services.

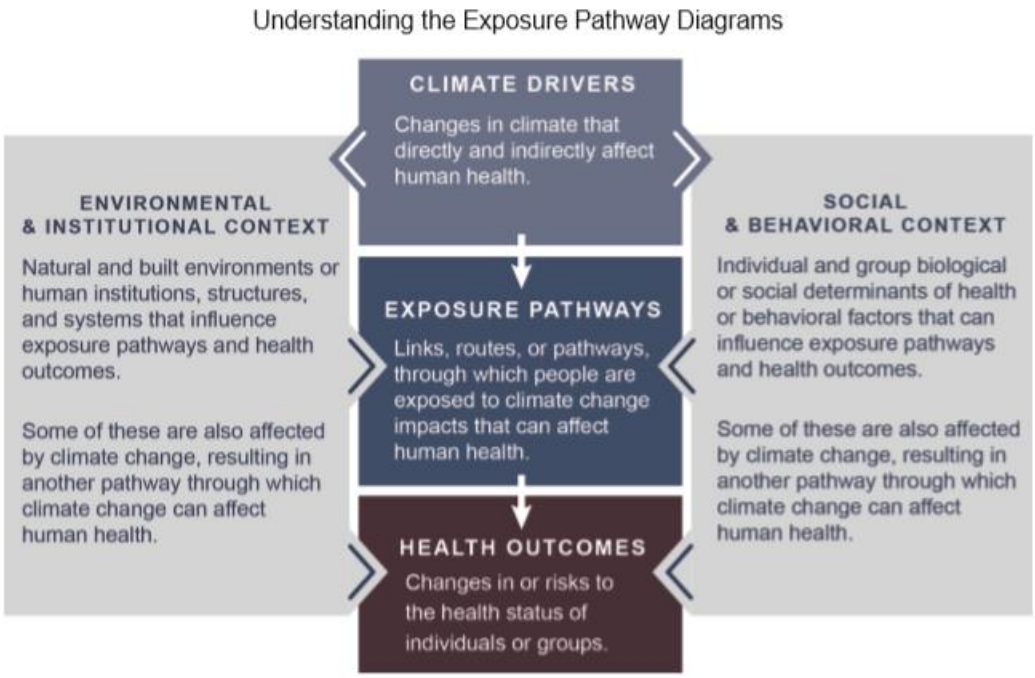
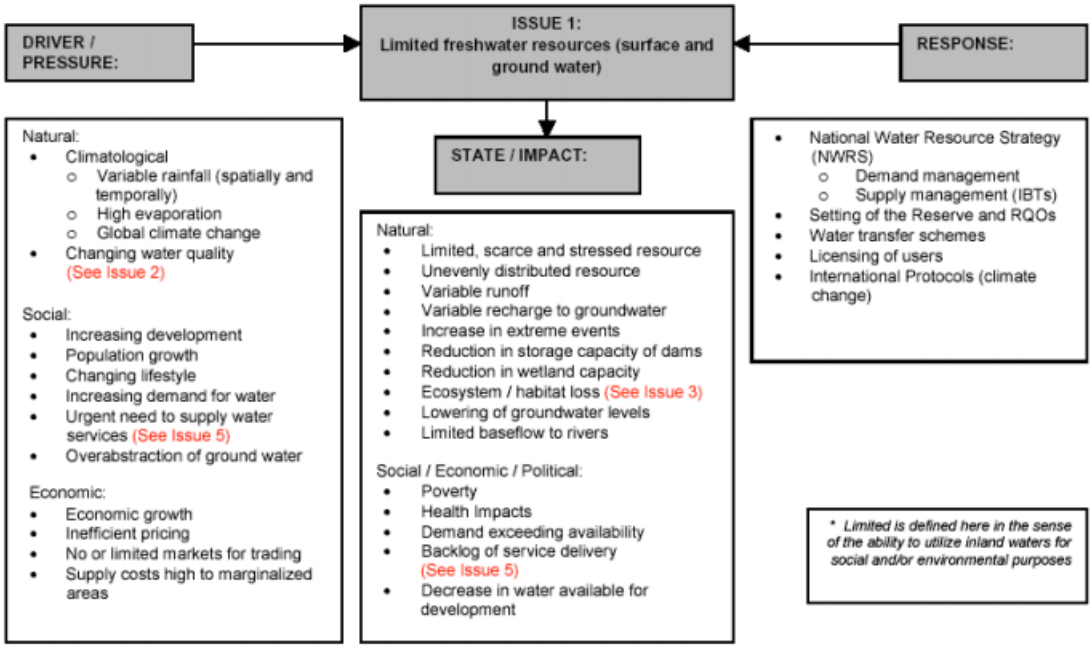


Figure 1: The center boxes include selected examples of climate drivers, the primary pathways by which humans are exposed to health threats from those drivers, and the key health outcomes that may result from exposure. The left gray box indicates examples of the larger environmental and institutional context that can affect a person's or community's vulnerability to health impacts of climate change. The right gray box indicates the social and behavioral context that also affects a person's vulnerability to health impacts of climate change. This path includes factors such as race, gender, and age, as well as socioeconomic factors like income and education or behavioral factors like individual decision making. The examples listed in these two gray boxes can increase or reduce vulnerability by influencing the exposure pathway (changes in exposure) or health outcomes (changes in sensitivity or adaptive capacity). The diagram shows that climate change can affect health outcomes directly and by influencing the environmental, institutional, social, and behavioral contexts of health.

S. Global Change Research Program x Impacts of Climate Change on Human Health in the United States

The following images (Kristensen, 2004) demonstrates the linkages between indicators for the capitals. The EEA Conceptual Framework for Ecosystem Assessment introduced in Appendix A derives from this framework.

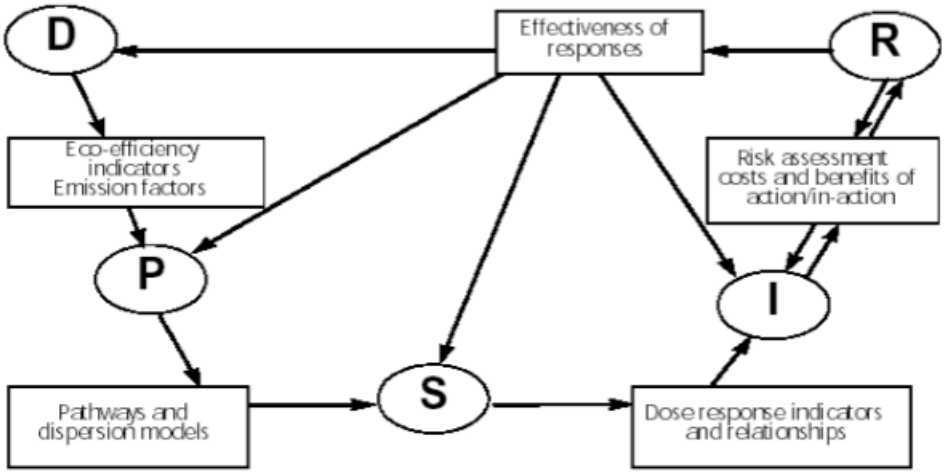
Figure 9: Conceptual DPSIR framework for issue 1: Limited freshwater resources.



Linking DPSIR elements

The DPSIR framework is useful in describing the relationships between the origins and consequences of environmental problems, but in order to understand their dynamics it is also useful to focus on the links between DPSIR elements (see Figure 3). For instance, the relationship between the 'D' and the 'P' by economic activities is a function of the eco-efficiency of the technology and related systems in use, with less 'P' coming from more 'D' if eco-efficiency is improving. Similarly, the relationship between the Impacts on humans or eco-systems and the 'S' depends on the carrying capacities and thresholds for these systems. Whether society 'Responds' to impacts depends on how these impacts are perceived and evaluated; and the results of 'R' on the 'D' depends on the effectiveness of the Response.

Figure 3: Indicators and information linking DPSIR elements.



G. Public and Private Sector Damage and Loss from Disasters

Several international efforts are underway to improve how ecosystem service assessments, or, in the context of this reference, public service assessments, can be used to mitigate and adapt to climate change. The EEA (2017) demonstrates the use of indicators, including ecosystem service indicators, to measure the impacts of climate change across the EUR. They stress the importance of improving the "knowledge bank" of climate change-related disasters and losses throughout the EU, noting that "economic costs can potentially be high, even for modest levels of climate change". They find "Climate-related extreme events accounted for almost EUR 400 billion of economic losses in the EEA member countries over the period 1980−2013. This accounts for 82 % of the total reported losses due to extreme events over this period, […]. Policies and actions would be facilitated by better collection of data concerning the economic, social and

environmental impacts of weather and climate-related extremes." The main body of this reference relates these public sector economic, social, and environmental impacts directly to private sector materiality indicators, including "ESG Factors".

The United Nations Environment Programme (2016) reference introduces 5 case studies that demonstrate how ecosystem based assessment approaches also can be used to assess the damages and losses to humans caused by climate change and why all 7 public capital stocks must be considered in the assessments. The stated purpose of their reference is to "[try] to advance understanding of climatic stressor effects on ecosystems and possible correlations and implications for societal losses and damages." Their approach, further defined in the following statement, helps to explain why Appendixes B and C introduce Social Performance Measures and Examples that demonstrate disaster loss assessment.

"The case studies show that causal links between climate change and a specific event, with subsequent loss and damage, are often complicated. Oversimplification must be avoided and the role of different factors, such as governance or management of natural resources [i.e. institutional capital], should be explored further. For example, lack of investment in water related infrastructure [i.e. physical capital], improved agricultural technology [i.e. economic capital], or health care services [i.e. human capital] also influences the risk of loss and damage."

The International Recovery Platform (2016) discusses why private sector companies have, in the past, depended on the public sector to make information accessible to them about the risks they face from climate change-related disasters –they simply didn't have the capacity to independently assess these risks. They cite research that has concluded "accountability among the public and private actors requires transparent and accessible disaster risk information". Their recommended solutions include government support for data platforms for collecting and sharing disaster risk information (i.e. see last section of this Appendix). In addition, this reference begins to show private sector companies how to independently assess these risks to help them to carry out better business continuity plans (BCP) (i.e. so that their businesses don't fail and jobs disappear). The authors use the following statement to describe the advantages of this approach.

"Through the development of a BCP, businesses will have analyzed the manner in which identified threats stand to impact their business processes, their people, their facilities and property, and their data. Using the knowledge gained through this exercise, they become better equipped to identify suitable risk reduction options or mechanisms to work around the problems that arise."

H. Public and Private Sector Monitoring and Evaluation (M&E)

DevTreks employs software objects, or Base Elements, in its applied, online resource conservation tools. Section F. Indicator Thresholds and WBSs, explained how to use Work Breakdown Structures to classify and communicate Resource Conservation Accounting Disclosures, or Indicators. Those Indicators are calculated and analyzed using calculators and analyzers linked to these base elements. The Work Breakdown Structure tutorial explains how to classify and communicate information contained in the base elements. For example, the M&E calculators can be linked to all base elements, including Outcomes and Outputs. In the context of public sector performance reporting, a public sector environmental agency might use the U.S. Department of Energy's WBS to classify Outcome and Output base elements associated with mitigation actions designed to reduce energy consumption. The previous section's Social and Private Risk WBS and Indicator Threshold tables can then be used to report on the performance of the mitigation and adaptation actions.

The OECD (2015) provides an international perspective about how countries are using monitoring and evaluation (M&E) "for the twin objectives of learning and accountability" when implementing public sector policies, programs, and projects, particularly related to climate change. As they put it "Learning aims to enhance stakeholders' understanding of the country's climate change risks and vulnerabilities that in turn can help to identify approaches that are effective in reducing those risks. Accountability aims to ensure that resources allocated for adaptation are effective in achieving set objectives."

The following image (EEA, 2015) illustrates how most EUR members have developed, or are developing, Indicator systems that can be used to monitor, report, and evaluate (MRE or M&E),

climate change adaptation actions. Appendices B and C will begin to demonstrate how to follow the KPMG advice (2016) to "align and harmonize" these Indicator systems.

Table 2.4 Indicator development within national-level MRE systems in Europe

Country	Status of indicator sets and types of indicators being developed (*)
Austria	An indicator system for monitoring and reporting on adaptation for 14 sectors, outlined in the Austrian Adaptation Strategy, has been developed. It includes 45 qualitative and quantitative indicators to monitor the processes, outputs or outcomes of adaptation interventions.
Belgium	The measures in the approved Flemish Adaptation plan (part of the Flemish Climate Plan 2013–2020) are evaluated annually in a progress report. A scale of progress is established for each measure. The future NAP will take a similar approach, with each action linked to qualitative or quantitative indicators. Other more specific plans have an in-built monitoring system in which weather events will trigger adaptation measures (e.g. the heat wave and ozone peak plan).
Finland	Evaluations of the NAS (2009, 2013) applied a five-step scale to indicate the level of adaptation in different sectors (see Box 2.10). Efforts to develop suitable adaptation indicators were initiated in 2015 to support the monitoring and evaluation of the NAP 2022.
France	Annual monitoring of progress is undertaken for 19 areas and one cross-sectoral theme outlined in the NAP (2011–2015). For each area and theme, an action sheet outlines one to six actions, each comprising several components that must be undertaken in that area, totalling 84 actions and 230 measures. These actions can be broadly categorised as (1) production and dissemination of information, (2) adjustment of standards and regulations, (3) institutional adaptation and (4) direct investment (from OECD, 2015).
Germany	Indicator system for reporting on climate change impacts and adaptation areas outlined (in the NAS). 102 indicators: 97 for impacts and adaptation and 5 overarching indicators (e.g. awareness of the public, research funding, international funding, funding for municipalities).
Ireland	Ireland is in the process of developing adaptation indicators.
Lithuania	The planned MRE systems will be indicator-based and linked to NAP (3-year cycle). It will focus on six main

EEA (2015) cites individual countries that have engaged private sector stakeholders to participate in these MRE systems. Several of those private sector stakeholders have expressed their desire for better risk management information and tools that permit them to take independent action to mitigate and adapt to these risks (i.e. so that their businesses don't fail and jobs disappear). For example, the following image (EMAS, 2017) shows how firms use M&E with the EMAS system of environmental reporting.

Once objectives have been defined, the next step is to set proper targets for them. With targets, it is possible to plan specific actions to be carried out to achieve good environmental management.

Figure 4

Relation between objectives, targets and actions

An example:

Environmental objective	Minimise hazardous waste generation
Target	Reduce the use of organic solvents in the process by 20 % within three years
Action	Reusing solvents whenever possible Recycling organic solvents

Objectives and targets should be measurable where possible, and consistent with an organisation's environmental policy. The 'SMART' criteria are useful:

— Specific — each target should address a single issue.

— Measurable — each target should be expressed quantitatively.

— Achievable — it should be possible to meet the targets.

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— Realistic — targets should be demanding and drive continuous improvement, but not overly ambitious. They can always be revised once they have been met.

— Time-bound — there should be a deadline for achieving each target.

I. Decision Making Processes And Valuations

The IPBES (2016a, chapter 5) reference introduces several decision contexts that can be used to assess ecosystem and public services. The CTA and CTAP tutorials introduce examples

demonstrating how to implement resource conservation decision support frameworks with communities and organizations. For example, the CTA reference includes a 10 step process used by the US NASA to assess project risks. The CTAP reference explains that subalgorithm 12, Resiliency Index (RI), uses the following 5 step process to assess urban resiliency to climate change: 1) Stakeholder Participation, 2) Stakeholder Consultations. 3) Initial Indicator Development, 4) Validation of the RI in Workshops, and 5) Participatory Evaluation of the RI. That reference also points out that beneficiaries take these approaches seriously because they are experiencing the heightened effects of climate change-related disasters, such as drought and typhoons, first hand. In the context of this reference, many of the beneficiaries have extensive experience dealing with deficient public sector institutions and private sector companies.

Because of the danger of attempting to measure everything while actually reducing risks for nothing, this reference recommends an adaption of the Resiliency Index's 5 step process for this framework, similar to the RAND (2016) use of a limited number of indicators for measuring priority project risks. For example, the following image (OECD, 2015) demonstrates how Australia prioritizes climate change risks. The prioritized social risks, or "drivers of change", and most important indicators, then follow the decision-making processes introduced next. Footnote 11 points out that, although the author has practical and extensive experience applying a similar framework, modern times requires modern online social networks to carry this out.

Table 3.1. **Prioritising climate change risks**

Likelihood	Consequences				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	*Medium*	*Medium*	*High*	*Extreme*	*Extreme*
Likely	*Low*	*Medium*	*High*	*High*	*Extreme*
Possible	*Low*	*Medium*	*Medium*	*High*	*High*
Unlikely	*Low*	*Low*	*Medium*	*Medium*	*Medium*
Rare	*Low*	*Low*	*Low*	*Low*	*Medium*

Source: Australian Government (2006), *Climate Change Impacts and Risk Management: A Guide for Business and Government*, Australian Greenhouse Office, Department of the Environment and Heritage, Canberra.

Federal agencies in the United States must follow uniform principles, requirements, and guidelines (PR&G) when planning sizeable projects that can impact water resource stocks (US CEQ, 2013; US CEQ, 2014; USDOI, 2015, Deal et al, 2017). PR&G uses the following general planning guidelines for evaluating changes to the services generated by water and land resources in the U.S.

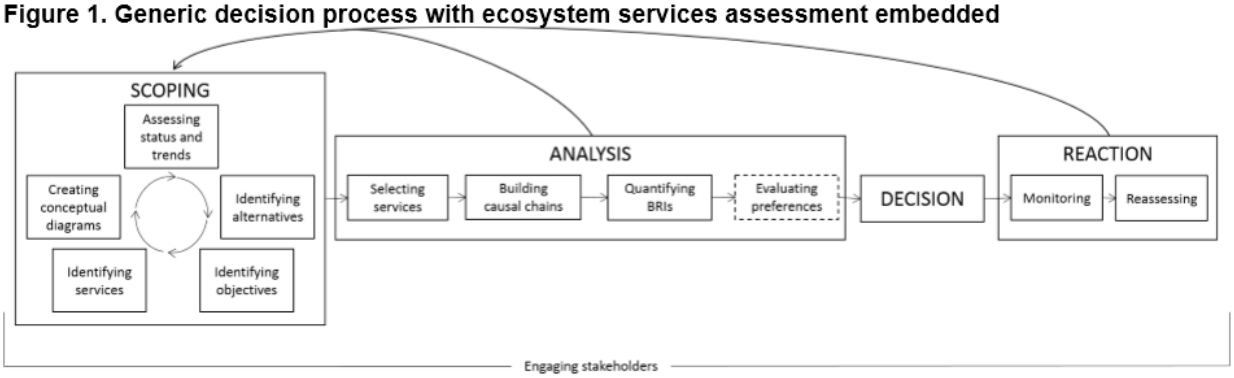
a. Scope the Level of Analysis.
b. Define the Purpose and Need
c. Formulate a Range of Alternatives
d. Project Future Conditions of the Study Area and Associated Impacts on the Affected Environment
e. Evaluate Alternatives
f. Display the effects/comparison of alternatives

The following image (NESP, Section 3, 2017) summarizes how this planning process works in the context of protecting and improving ecosystem services. This reference substitutes the more general term, public services, for ecosystem services.

Ecosystem Services Assessment in Decision Processes

This guidebook organizes the ecosystem services assessment methods around an example planning process using four general stages: (1) scoping, (2) analysis, (3) the decision, and (4) reaction (Figure 1). These stages also occur in other comprehensive decision-making approaches, such as economic valuation and structured decision making, elements of which are included in this framework.

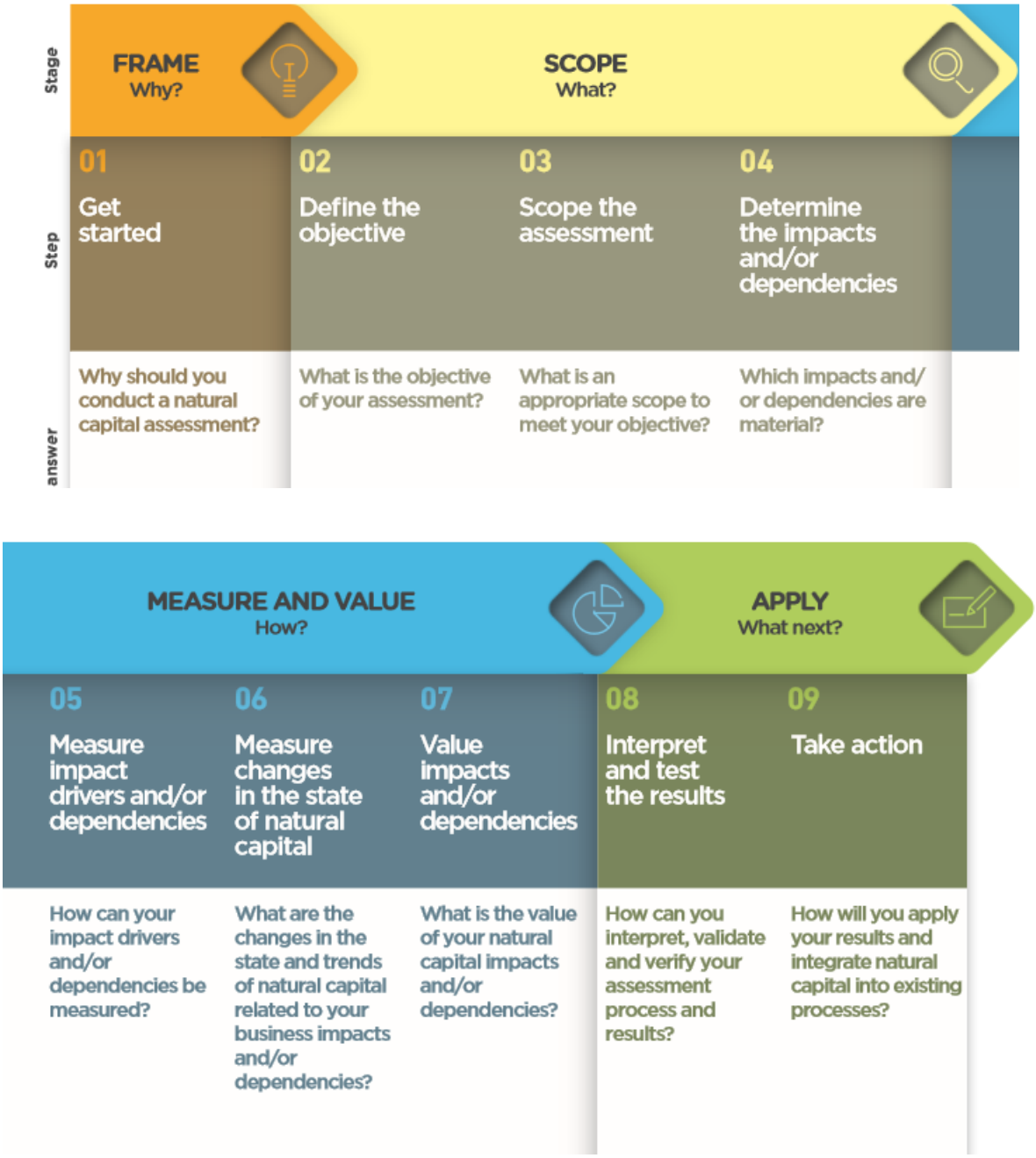
Figure 1. Generic decision process with ecosystem services assessment embedded



Note: Integrating ecosystem services considerations into the decision making process—that is, translating ecological changes into implications for people—requires changes throughout the decision process, particularly in the scoping and assessment phases. Stakeholder engagement continues through the full decision process.

The Natural Capital Coalition (2016) introduce the following 9 step process that private sector firms can use to improve how they make decisions related to their management of natural capital and their impact drivers and dependencies on biodiversity. Section B in this Appendix explains how this process relates directly to ecosystem assessment decision support processes used by federal and international agencies.

0.2 The Natural Capital Protocol Framework



The USGCRP (2016) relates these types of decision making processes with stakeholder valuations with the following statement "Understanding costs and benefits of different decisions requires understanding people's preferences and developing ways to measure outcomes of those

decisions relative to preferences. This "valuation" process is used to help rank alternative actions, illuminate tradeoffs, and enlighten public discourse."

The following image (Jacobs et al, 2016) summarizes scientific efforts to use an "Integrated Valuation" approach, rather than historical single valuation techniques, to assign values to ecosystem services when making decisions that change resource stocks. Examples of single valuation techniques include step 07 in the previous image, and the Santos-Martín (2016) images displayed in the Social Performance Indicator Threshold Overview section. The IBPES (2016b) reference uses the term "Pluralistic Valuation" (Chapter 5) in a similar manner.

S. Jacobs et al. *Ecosystem Services 22 (2016) 213–220*

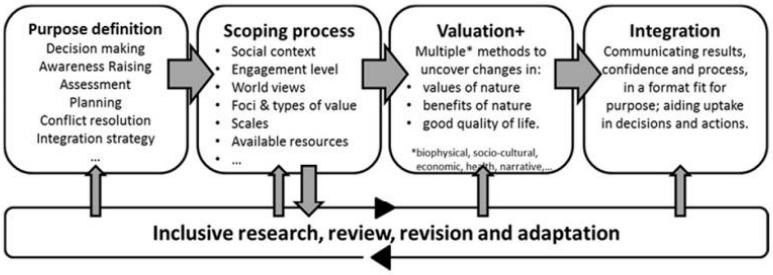


Fig. 1. Simplified schematisation of the current state-of-the-art approach for integrated valuation and its main components. (adapted from Kelemen et al., 2015; Gómez-Baggethun

These decision making approaches recognize that multiple groups of stakeholders value ecosystem services differently based largely on their perceptions of which public capital stock characteristics are important to them. Some groups place higher value on the indigenous knowledge pertaining to cultural capital stocks, others on the social equity associated with social capital stocks, while others believe that natural capital stocks have intrinsic values that escape measurement. The authors advocate these multi-stakeholder, multi-capital, multi-valuation, approaches for assessing service value. They believe these approaches will lessen the severe conflict, inequity, and dissatisfied customers, which can arise from making decisions and taking actions that don't account for the tradeoffs and synergies needed to balance the interests of diverse stakeholders. Chapter 6 in the IBPES (2016b) reference gives concrete examples of tradeoffs and synergies between ecosystem services, stakeholders, and mitigation and adaptation responses. The following image (Antonopoulos et al, 2016) illustrates tradeoffs between

ecosystem services, species abundance, and land use intensity. In this example, provisioning services can be increased (i.e. food or timber production), but other services must be reduced resulting in an overall decline of ecosystem service values, or, in the context of this reference, Social Performance Measures.

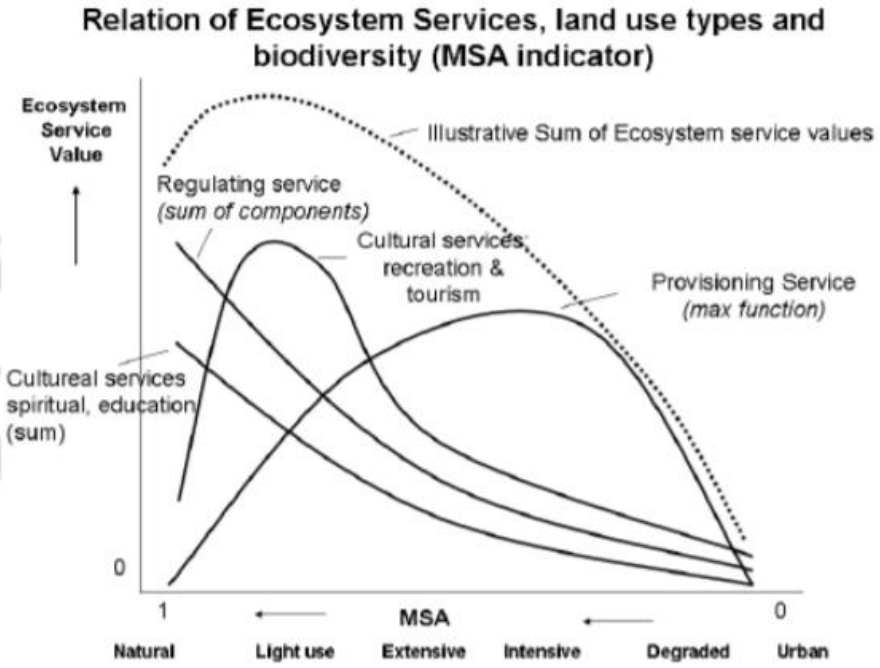


Figure 3.4. General relationship between different ecosystem services, mean species abundance (MSA) and land use intensity (Braat and ten Brink, 2008)

One historical explanation for this tradeoff is that certain powerful stakeholders, and the social norms at the time, placed high value on economic production. An elite group of owners may have captured most provisioning service values because formal institutions that protected social equity were immature or compromised by corrupt politicians captured by special interest groups. Less powerful stakeholders, such as bird watchers or tourists [or in the case of the author, sunset watchers], placed higher value on enjoying diverse wildlife, but had much less social popularity and political influence. Ecosystem services, and any other public service, can't be protected or improved properly without thoroughly addressing the economic, social, cultural, and institutional, "drivers" that explain service management.

La Notte et al (2017) summarize prominent ambiguities in how researchers define the terms used in these types of ecosystem frameworks and their applied WBSs, including ecosystem structure, processes, functions, services, and benefits. They point out that such ambiguities can result in double counting the services generated by ecosystems. For example, if provisioning services include crop biomass, and a regulating service includes pollination, the resultant valuation assessment can easily double count the crop production benefits generated by the two service flows. They employ a system ecology perspective to propose the following definitions for the terms used in ecosystem assessments.

398 *A. La Notte et al. / Ecological Indicators 74 (2017) 392–402*

Table 2
Proposed definitions of the cascade framework terminology.

Term	Definition	Examples[a]
Biophysical structure[b]	The setting for ecosystem components (biotic and abiotic). This also relates to the ecological pattern	Forest tree cover Inland water bodies
Process or function	An ecological interaction among components in an ecosystem over time. Processes may generate several ecosystem services.	Net primary production Carbon cycling Nutrient cycling
Ecosystem service	A flow generated by the ecosystem including ecological interactions and information which are useful to human beings. We therefore propose that ecosystem services do not include ecosystem components or goods, i.e. countable as (bio)mass unit. In addition, ecosystem services sometimes require human input, which does not necessarily mean human-made constructs like labour, industrial processing, benches or fishing roads.[a]	Generation of material from plants Carbon sequestration Water purification Aesthetic beauty of landscape
Good	Countable as a (bio)mass unit, it is a vehicle for ecosystem service enjoyment.	Wood biomass Amount of CO_2 retained from the atmosphere Amount of pollutants retained from water bodies People enjoying outdoor recreation activities
Benefit	What is generated by the service and leads to a change in human well-being.	Availability of wood for multiple uses Healthier air to breath/climate change mitigation Availability of cleaner water (instead of water polluted by economic activities)

[a] Example of human input includes existence of a human being with his/her sensory and perceptional experiences.
[b] Existing literature often uses the term ecological structure as a synonym for biophysical structure. We however prefer the later term, because it also includes non-vegetated structures, such as dunes, aquifers or Rocky Mountains.

Olander et al (2015) discuss how to use experts trained in valuation assessment to avoid double counting when using "ecosystem service causal chains", which, in the context of this reference, includes "social impact pathways" and "results chains". The Indicator Threshold and Scoring systems used in Appendices B and C must employ Indicators in a way that avoids double counting of services and subsequent valuations. They must also evolve as these scientific issues become resolved (**11***).

J. Communicate Results

The following images (EPA 2016, RAND 2016) demonstrate how the results of risk reduction assessments can be communicated to decision makers. A third dimension or additional point estimates, that distinguish the difference in importance to a company versus community, can identify tradeoffs and enhance communication further.

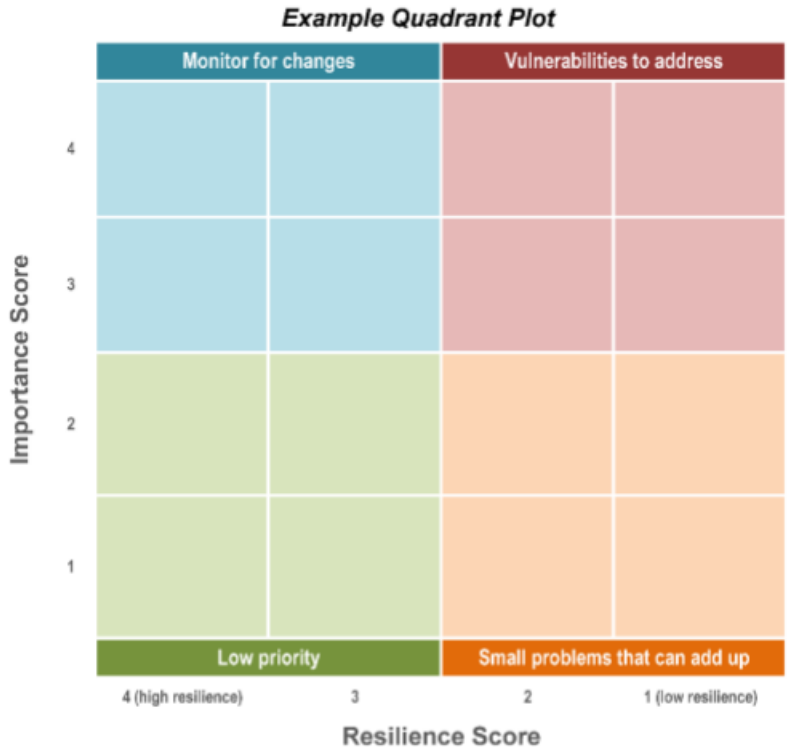


Figure 2. Example quadrant plot.

These graphics facilitate the interpretation of case study results and are intended to further assist city managers in moving to the next step of implementing climate change adaptation activities. For example, if a qualitative or quantitative indicator ranked as highly important is also identified as demonstrating high resilience, the city may be considered resilient with respect to that data point or topic ("Monitor for Changes"), meaning the city is either inherently resilient or has already taken steps to increase resilience. For example, Washington, DC received high resilience and importance ratings for:

Figure 4.6
Risk Factor Consolidated Assessment and Radar Chart

Statement	Boundary Condition Concerns	Weight Defined) (User (0-5)	Value (0-5)	Weighted Value (Score X Weight)	Normalized Value (Weighted Value/ Total Weight)
Stability of sources					
Alternative sources					
Materials					
Services					
Quality management					
Total					

RAND RR1537-4.6

The following 2 images demonstrate how the IPCC recommends communicating information about the risk and uncertainty of resource stock measurements.

Quantitatively Calibrated Levels of Confidence	
Terminology	**Degree of Confidence in Being Correct**
Very high confidence	At least 9 out of 10 chance of being correct
High confidence	About 8 out of 10 chance
Medium confidence	About 5 out of 10 chance
Low confidence	About 2 out of 10 chance
Very low confidence	Less than 1 out of 10 chance

Likelihood Scale	
Terminology	**Likelihood of the Occurrence/Outcome**
Virtually certain	>99 percent probability of occurrence
Very likely	>90 percent probability
Likely	>66 percent probability
About as likely as not	33 to 66 percent probability
Unlikely	<33 percent probability
Very unlikely	<10 percent probability
Exceptionally unlikely	<1 percent probability

The following image (IPBES, 2016a) demonstrates how the IPBES recommends using these types of qualitative rankings to further categorize "the qualitative communication of confidence".

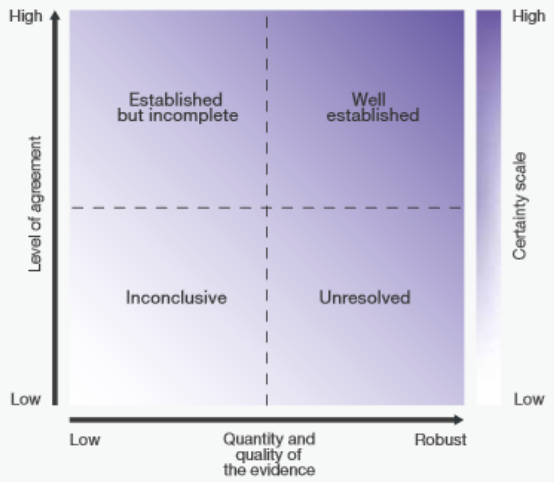
In this assessment, the degree of confidence in each main finding is based on the quantity and quality of evidence and the level of agreement regarding that evidence (figure SPM. A2). The evidence includes data, theory, models and expert judgement. Further details of the approach are documented in the note by the secretariat on the guide to the production and integration of assessments of the Platform (IPBES/4/INF/9).

The summary terms to describe the evidence are:

- **Well established:** comprehensive meta-analysis[23] or other synthesis or multiple independent studies that agree.
- **Established but incomplete:** general agreement although only a limited number of studies exist; no comprehensive synthesis and/or the studies that exist address the question imprecisely.
- **Unresolved:** multiple independent studies exist but conclusions do not agree.
- **Inconclusive:** limited evidence, recognizing major knowledge gaps.

FIGURE **SPM.A2**

The four-box model for the qualitative communication of confidence. Confidence increases towards the top-right corner as suggested by the increasing strength of shading. Source: modified from Moss and Schneider (2000).[24]



GIS

This reference treats GIS mapping as a useful tool for communicating the results of this framework (and possibly the most useful communication aid). But, unlike most of the background references, it doesn't treat GIS as an essential tool because it adds further complexity to applying the framework and achieving results, and because not every capital stock assessment needs geographic analysis. Specifically,

1. **Social Networks, Clubs, and TEXT and HTML First (14*)**. The applied tools introduced in Appendix B only require access to a web browser, ability to use URIs and build TEXT files, and the ability to "click" on, or touch, web pages. Two of the most important principles explained in Section A involve "transparent reporting" and "adoption of applied online tools". Those principles can be achieved by using URIs to make all of the input and output data available as TEXT datasets, with results that get transparently displayed as standard, 2-dimensional HTML.
2. **Secondary Data Second**. Most GIS mapping simplifies reality, often shakily, by relying on readily available secondary data, such as census data. Most of the serious data needed to achieve results in this framework, such as standardized public service data, multi-stakeholder valuations, or standardized mitigation and adaptation impact data, isn't available. It's not clear that the satellites, or the public censuses, relied on by organizations such as the EEA can deeply change the availability of the needed data (i.e. for all 7 capitals). That probably explains the need for Footnote 11, the likelihood of Footnote 16, and most of this reference.
3. **GIS Data Third**: GIS requires the skills of GIS specialists who have access to specialized GIS data. It represents another black box hurdle that professionals who may be capable of applying this framework should not have to immediately overcome. If the Locational Indexes introduced in Section C work, even primitively, that data can be "upgraded" to GIS data in future releases (i.e. refer to Appendix C in the Technology Assessment 2 reference).

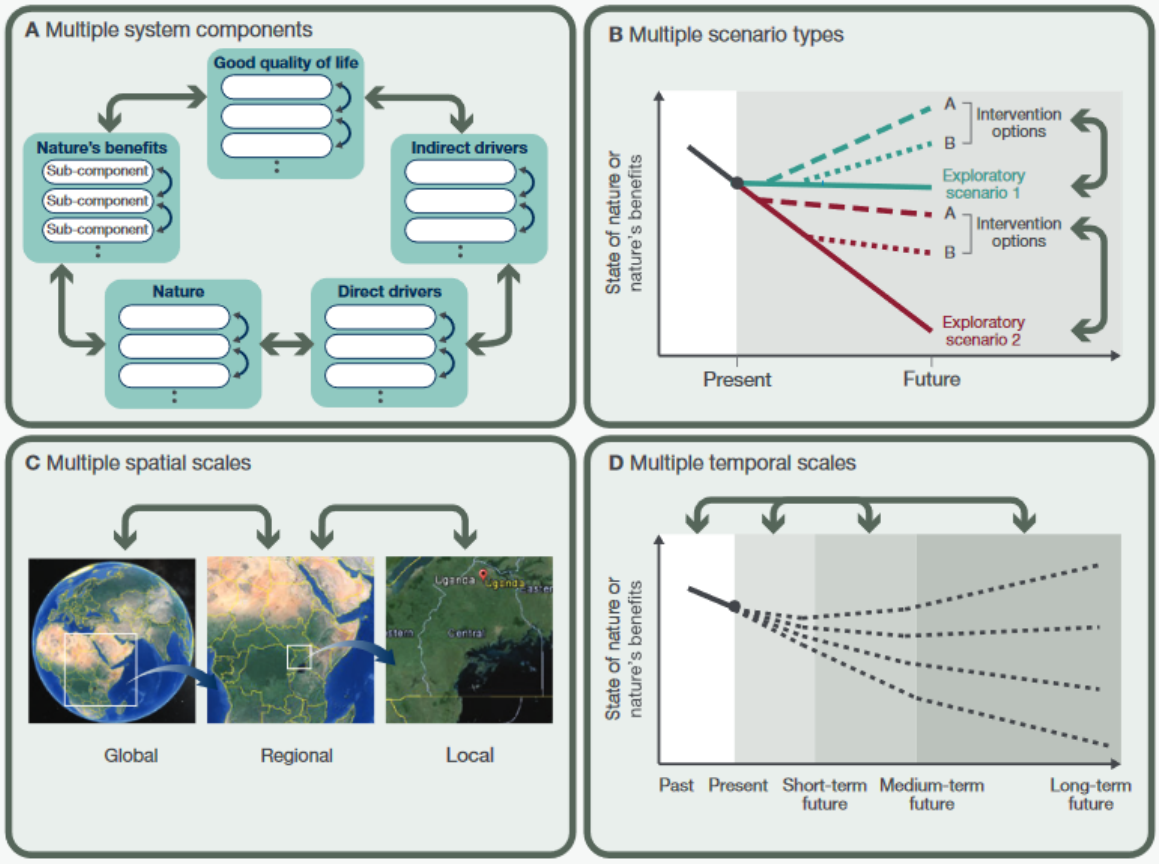
K. Applied Resource Conservation Accounting (RCA) Algorithms and Platforms (12* and 16*)

The CTA reference explains that the primary characteristic of CTAs is their use of online algorithms to measure the risk and uncertainty of Indicators. The Indicator threshold and boundary metrics, introduced in Section D, account for risk and uncertainty, thereby supporting Section A's principle, Reports the Risk and Uncertainty of Stock Balances. Additional CTA techniques, including scenario analysis, spatial and temporal scale trends, multi-stakeholder service valuations, vulnerability assessment, and more advanced mathematical algorithms, are needed in order to use CTAs as an overall digital decision support platform for implementing this RCA Framework.

The following image (IPBES, 2016a) introduces an international ecosystem assessment framework currently being developed as such a digital platform. The image shows that more comprehensive decision support platforms integrate natural resource/human system modeling (i.e. Multiple System Components), multiple scenario types, multiple spatial scales, and multiple temporal scales. Although not transparent, the framework's overall performance objective, Good Quality of Life, must be defined in terms of the values of diverse stakeholder groups. In relation to this RCA Framework, that performance objective is an integral part of the decision making processes introduced in Section H that apply the framework.

FIGURE **SPM.8**

Linking scenarios and models in four key dimensions: system components, scenario types, spatial scales and temporal scales, with the thick grey arrows indicating linkages within each dimension. Panel A illustrates linkages between scenarios and models across the different components of the conceptual framework (thick grey arrows) as well as between their sub-components (thin blue arrows; for example linking biodiversity with ecosystem function sub-components of nature). Panel B shows ways in which different types of scenarios, such as exploratory and intervention scenarios, can be linked. Panel C indicates linkages across spatial scales from local to global. Panel D illustrates the linking of the past, the present and several time horizons in the future (dashed lines indicate a range of exploratory scenarios). Two or more of these dimensions of linkages can be used in combination (e.g., linking different types of scenarios across spatial scales). See chapter 6.2 and figure 6.1 for details.



Appendix B. Social Performance Measures, introduces new or upgraded algorithms that apply this framework. They also begin to demonstrate how to link the models, stakeholder valuations, scenario types, spatial scales, and temporal scales, needed when using CTAs as a digital decision support platform, similar to the linkages displayed in the following image (IPBES, 2016a).

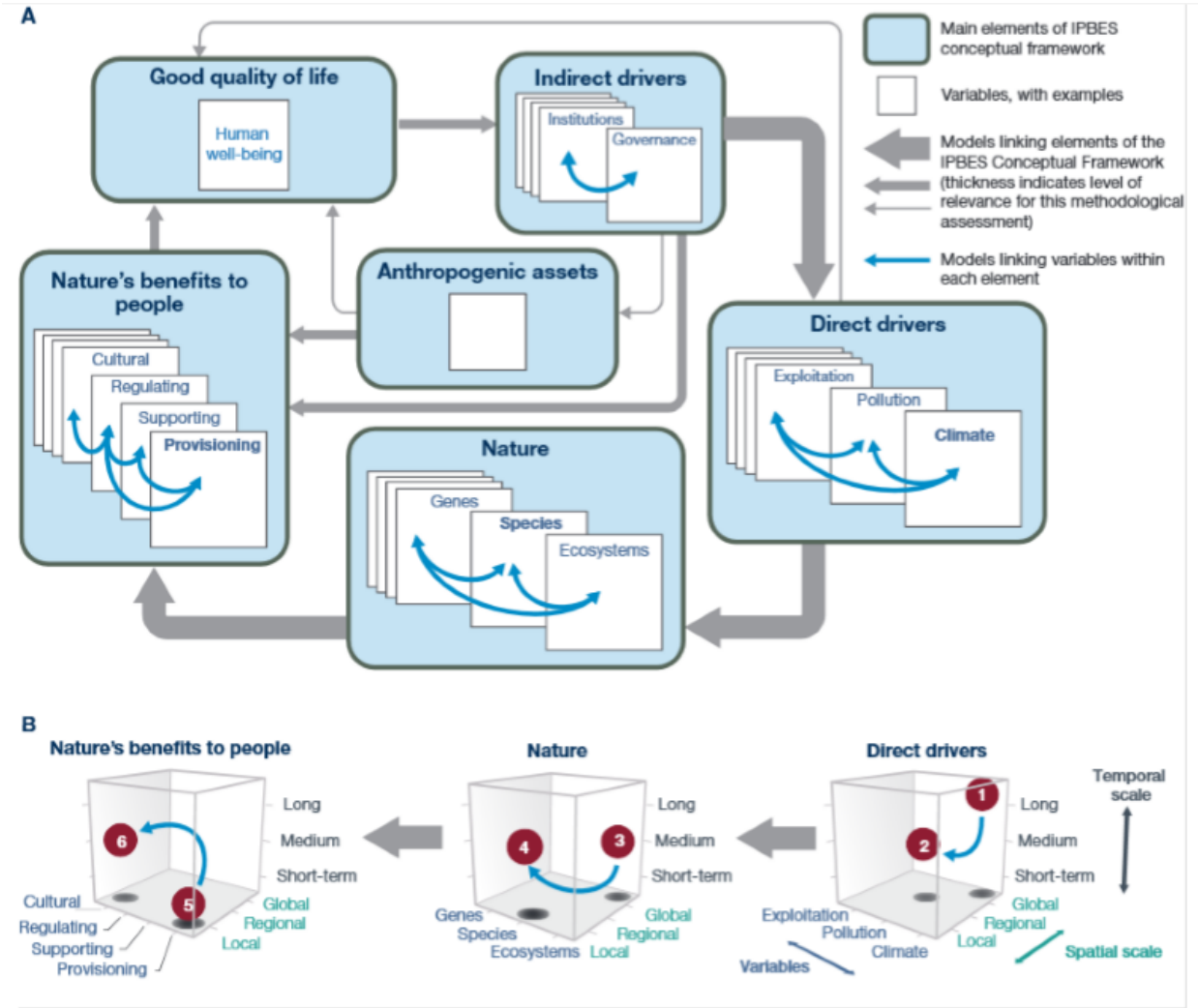


Figure 6.1: Linking models among the six elements of the IPBES conceptual framework, among variables (or organizational scales) within each element, and among spatial and temporal scales of each variable. Each element has multiple dimensions (Panel A) including temporal and spatial scales, and disciplinary and organizational domains. Blue arrow explained in text. Panel B provides illustrative examples of how linking and harmonizing models facilitates assessment of biodiversity and ecosystem services. For example, centennial-scale outputs from climate and ocean conditions from global-scale Earth System Models (1) can be used as inputs to project decadal and regional changes in level of marine contaminants e.g., methyl-mercury (2). Outputs from (1) and (2) can be used to project changes in regional marine ecosystems structure and functions (3), which can then be linked to

Additional algorithms will be introduced in future releases that use much more technology-intensive approaches, such as recent Artificial Intelligence approaches (**15***).

L. Mainstreamed Resource Stock Assessment Platforms

The OECD (2015) inadvertently makes the following point about achieving economies and scale in the collection, management, and delivery of public and private sector performance data. "The data constraints countries face in the context of [climate change] adaptation are similar to the constraints they face when monitoring and evaluating other development priorities. Lessons learned from development practice can, therefore, inform development support targeted at enhancing data availability for [climate change] adaptation."

UNEP DTU (2016) points out that Monitoring and Evaluation of climate change adaptation, like many Indicator Assessment approaches, is too complex and expensive for approaches that are not being "mainstreamed". By mainstreaming, they mean applied in multi-stock, multi-sectoral, multi-scale, multi-valuation, integrated, digital platforms. In the context of this reference, they also mean multi-model, or "multi-algorithm". In practice, that means this RCA Framework must demonstrate, in Appendices B and C, practical ways to "align and harmonize" (KPMG, 2016, UN-SETAC 2016), or "mainstream", the immense number of Indicators, Indicator systems, and stock assessment techniques found in the references, The World Health Organization (O'Neill et al, 2016) and UNDP (2016a, 2016b) demonstrates the process.

Biologists, climate scientists, ecologists, malnutrition M&E experts, disaster risk assessors, stock valuation experts, investment advisors, company CFOs, sustainability officers, auditors, and public sector managers, must find "mainstreamed platforms" to jump on board, or each group will continue reinventing the same wheel. These professions should develop Indicators and "algorithms", customized for their purposes, but not to develop thousands of competing, single sector, single capital, single country, single valuation, single model, expensive IT platforms for assessing resource stocks. Just because funding sources outside of the Silicon Valley may not understand "mainstreamed platforms" very well, and therefore bestow large sums of money to build "special interest group platforms", that's not an excuse for harmful IT policy (**12***). The risk of deterioration to public services may lead to "unwise" citizen quality of life –with a downward spiral that benefits no one.

This reference demonstrates how to develop generic tools and platforms that use widely accepted Indicator systems to protect and improve generic public capital stocks and services by using generic public and private sector performance assessments. Mainstreaming, as applied in generic, online knowledge platforms, allows economies of scale and scope to be realized, public service risk reductions to be widespread, and companies to be admired or admonished.

Appendix B. Social Performance Measures

The following metrics provide proof of corporate and public entity claims made in financial reports about the risk and uncertainty associated with their impacts on their community's human capital, physical capital, economic capital, natural resources capital, social capital, cultural capital, and institutional capital. In order to support the Section B principle, Supports Transparent Corporate and Public Sector Materiality Reporting**,** the story behind these Measures must be told thoroughly and well. These types of measures assume that social networks (even if currently nonexistent) share the development burden because they understand what "unwise citizen of quality of life" means for them and their descendants and what economies of scale and scope imply for risk reductions (**11***).

A. Total Social Performance Score for Companies and Communities

All Indicator Threshold systems must integrate widely accepted Risk Reduction Indicator systems, such as the UN's SDGs and climate change-related Sendai DRR Indicators or the EU's EMAS Indicators, with this framework's RCA WBS. Individual Indicators are customized for specific sectors, specific capital stock assessments, and public versus private sector purposes, but they must be applied using the same dataset structures and algorithms. These systems must allow them to be used in a wide assortment of assessments, including RCAs, M&Es, DRRs, and S-LCAs.

If not defined carefully, the Indicators used to define the "impact pathways" in these systems can easily double count the benefits, or Impacts. Example 1 will illustrate how the value of biodiversity improvements can double count crop production service values arising from mitigating the Freshwater Supply and Pollination risks or "stressors". The best way to avoid double counting is to fully understand the underlying science and then "proof" these systems with extensive field work (i.e. which this nonconventional ngo's resources don't allow).

Generic Threshold Levels. Up to 7 levels of Indicator Thresholds are defined in a generic way that allows them to be used for all Indicators within an Indicator Threshold system, or within the system's Indicator Factors. The following examples employ the RAND scoring technique, which converts qualitative indicators to quantitative high and low values that will be normalized when used in scoring systems.

Generic Indicator Thresholds							
qualitative	strongly positive	moderately positive	slightly positive	none or neutral	slightly negative	moderately negative	strongly negative
quantitative	6	5	4	3	2	1	0
qualitative	not used	unacceptable	extremely high	high	moderate	some	low
quantitative		5	4	3	2	1	0
qualitative	not used	not used	not used	highest resilience	medium high resilience	medium low resilience	lowest resilience
quantitative				3	2	1	0

Indicator Threshold Systems. Indicator Thresholds TEXT datasets must be defined in a general enough way to allow them be used for systems of Indicators applicable in a wide array of quality of life scenarios. Characteristics of these systems include:

1. **Social Networks and Clubs**. Objective, science-based, online, social networks build and maintain these Threshold Systems for priority resource stocks. The initial Indicators used in these systems should correspond directly to established Indicators systems, such as the SDG, Sendai DRR, and ISO 14001. Individual clubs customize them when applied for their own purposes.
2. **Customer-focused Thresholds**: The degree of effort spent on developing Threshold systems should be proportionate to the issues being addressed. RAND (2016) demonstrates how some companies and organizations develop very applied and prioritized systems with a small number of Indicators. At the other end of the scale, USEPA (2016) demonstrates how these systems may require hundreds of Indicators to

deal with major issues with severe consequences, such as increasing the resiliency of large urban cities to climate change.

3. **Driving Factor, or Impact Pathway, Indexes.** The driving factor, or Indexes, used with each Indicator derive from the 7 capitals.
4. **4 Hierarchical Indicator Levels Rooted in the Capitals.** Using the example of social impact pathways, Separate Indicator Thresholds must be defined for "impact pathways", "causal chains", "exposure pathways", or "results chains" rooted in the capitals, whether this reference's 7 capitals, or the 3 capitals employed by many of the third party references (i.e. Environmental, Socioeconomic, and Corporate Governance). In the example of social impact pathways, the 4 levels are translated into Actions (AF), Conditions (CF), Services (SF), and Impacts (IF) in specific industries (i.e. coffee production).
5. **Location-based Thresholds**. Separate Thresholds can be defined for locations or ecosystems (i.e. locationid column).
6. **Multiple Rating Systems**. Multiple threshold ratings can be used within these systems (i.e. by inserting new rows with the new rating system above the appropriate factors).
7. **Public and Private Sector Uses**. Indicators are defined in general terms that can be used for private and public sector purposes.
8. **Quantitative Relative Scores**. Their corresponding scoring systems will convert the qualitative Threshold values to quantitative scores. The Thresholds and Scoring systems must guard against double counting service values.
9. **TEXT Datasets**. The raw scoring data result is returned as comma-separated-value TEXT datasets. Be careful not to use any commas in the original Indicator and Index names. This TEXT file is then used to build whatever multimedia support is desired, such as tables showing percent change between periods, or EPA-style graphs displaying the areas of lowest urban resiliency.

The following examples illustrate these characteristics. A critical part of these Thresholds is to understand and correctly identify the linkages and interactions in the social impact pathways or results chains. Automating these linkages will continue to be a future goal, or "release".

Indicators use the following labeling conventions. The references used in this tutorial suggest that the main limit introduced in this labeling system, 26 characters in the alphabet, will not impose a serious constraint.

Total Risk Indexes must start with the hardcoded characters "TR" and contain no more than 3 characters.

Locational Indexes must contain no more than 2 characters. This reference recommends using the following labeling conventions: NC = Natural Capital, IC = Institutional Capital, HC = Human Capital, EC = Economic Capital, PC = Physical Capital, SC = Social Capital, CC = Cultural Capital. Large scale Indexes may want to customize them for large scale issues.

Categorical Indexes must contain no more than 3 characters. This reference recommends using the following labeling conventions: NCA = Natural Capital Index1 … NCZ = Natural Capital Index26.

Indicators must contain at least 4 characters. This reference recommends using the following labeling conventions: AF1A = Action Indicator1 … AF1Z = Action Indicator26, CF1A = Condition Indicators, SF1A = Service Indicators, IF1A = Impact Indicators.

Version 2.1.2 moved all examples into Appendix C.

Note how the UN SDG Indicators (Indicators such as 6.5.1) have been integrated into these systems. The "Action Indicators" (i.e. AF1A = Action Indicator 1) can be defined as SDG risks, as industry or company risks and activities, or as the "climate and ecosystem stressors" found in several of the ecosystem assessment techniques introduced in Appendix A.

Although these thresholds are fictitious, it's possible that some scientific organization may have already established thresholds for the SDGs, DRRs, and other established systems. If not, a new

"Resource Conservation Accounting Standards Board" may be needed (i.e. none of the existing standards organizations introduced in this Appendix use this type of risk assessment approach) (**5***). Customers should not have to independently complete unique Threshold Systems when they use Social Performance Measures.

In practice, these types of Thresholds, as well as their applied Scoring systems, are usually developed by interdisciplinary teams, such as online social networks that include biologists, ecologists, engineers and social scientists. That helps to explain deficiencies in these tables (**11***).

Indicator Scoring Algorithms. Algorithms convert Qualitative Threshold levels, as defined by a corresponding quantitative Threshold score, to quantitative scoring systems (i.e. similar to the RAND, Eurostat, OECD, FAO, and Technology Assessment 2 techniques). In this example, the quantitative thresholds defined in the previous Indicator Threshold tables are used to score each trend period. Algorithms use these values to run calculations and fill in the final scores, Index rows, and parent Indicator properties.

The 4 level Indicator hierarchy used with the Scores offers flexibility in how Scores are defined. The characteristics of the hierarchy used in the following table include (refer to the Technology Assessment 2 tutorial for further details about these 4 levels):

1. **4 Indicators and a Score**. Using the example of social impact pathways, each base element uses 4 separate Indicators to score the RCA Framework: Indicator 1 = Actions, Indicator 2 = Conditions, Indicator 3 = Services, and Indicator 4 = Impacts. The Score is defined flexibly, such as actual impacts as percentage of target impacts or actual impacts as percentage of benchmark impacts.
2. **Locational Indexes.** These Indexes are the principal "drivers of change" that are being addressed, or fixed. Example 1 includes Natural Capital, Physical Capital, and Economic Capital as Locational Indexes. Example 2 includes Habitat Change, Climate Change, and Overexploitation as Locational Indexes. The Locational Indexes are based on the purpose

for the capital stock assessment and can include issues such as Civil Rights and Gender Equality.

3. **Categorical Indexes**. The main factors, or explanatory factors, influencing the Locational Index are defined by multiple Categorical Indexes, such as Natural and Economic Capital in Example 1, and Economic Development and Land Use in Example 2. The Categorical Indexes come directly from the background Indicator Threshold systems. Multiple stocks from the 7 capitals can be, and usually are, used as explanatory factors, or Categorical Indexes. Although not demonstrated yet in this reference, sophisticated algorithms are available (i.e. see OECDb, 2008) for generating scores using this type of Indicator system.
4. **Indicators**. Each Categorical Index contains one or more Indicators used for scoring. Each separate Indicator can include 3 types of Indicators in separate 4 level hierarchies: benchmarks, targets, and actuals. Appendix A, Example 1 demonstrates how these Indicators are used for monitoring and evaluation, or "learning and accountability".
5. **Quantitative Relative Scores**. Their corresponding scoring systems will convert the qualitative Threshold values to quantitative scores. The Thresholds and Scoring systems must guard against double counting service values. RAND (2016) describes the use of these scores as follows: "In such an [normalized and weighted Indicator] analysis, absolute values are far less important than relative comparisons of those values. Such normalization allows one to assess where among the [] risk areas where [] leadership should have the most concerns and ultimately where resources could or should be allocated to mitigate risks and improve chances of mission success. In the classical risk assessment format, when risks are represented by the likelihood of some outcome occurring (e.g., 10 percent of five fatalities), absolute values are very important. Once these risk values have been normalized to a common ordinal scale (e.g., 1-to-5 scale), the values become less descriptive and therefore lack the actionable aspect of their classical counterpart." The last statement explains why these Threshold Systems will be explained further with new quantitative and qualitative algorithms.
6. **Optional M&E**. If using this algorithm for M&E, Mitigation and Adaptation Alternatives must contain an underscore followed by at least 1 character. We suggest the

following convention: "_A" … "_Z". These Indicators act as targets, and the initial Indicators serve as benchmarks. This reference recommends using the following convention for Indicators acting as actuals: "_AA" … "_AZ". The examples in Appendix D document alternative, simpler, ways to conduct M&E with this system.

7. **Adaptive Efficiency**: This reference acknowledges the difficulty, or social engineering hubris, of establishing a complete science that fully quantifies the socioeconomic factors influencing public services. An argument can be made that no one has fully achieved that accomplishment yet. Nevertheless, most of the references, as well as the author's direct experience, suggest a) the importance of starting to establish a scientific basis for these measurements, b) the learning, and increasing stock of knowledge, that takes place allows the science and supporting institutions to evolve, and c) the collaborative process used to complete Social Performance Measures at least helps to identify "socially acceptable paths forward".

Appendix C. Examples (15*)

Appendix C has been moved to the sibling reference, Social Performance Analysis 2.

Appendix D. Definitions of Social Performance Terms

This Appendix defines the principal terms used in this reference. These informal definitions derive from the author's experience and current work in technology development. Readers are encouraged to think more deeply about these terms, and to produce their own tutorials, by referring to dictionaries, encyclopedias, and scientific publications (i.e. see the Glossaries and Annexes in the UN 2014, TFCRFD 2016, GRI Standards Glossaries, EU MAES 2016, US CEQ 2013, and IBPES 2016, references).

Public Goods or Public Capital Stocks. Any asset that is not privately owned and generates services demanded by people. Private ownership must be established through widely enforced laws (**8***). The laws get established by a community's formal, rather than informal, institutions (i.e. courts). The formal institutions must not be corrupt, in the process of being corrupted, or in a serious state of decline.

Public Services: Public services, such as ecosystem services, are the direct or indirect contributions, including economic, environmental and social effects, which public capital stocks, such as ecosystems, make to the environment and human populations.

Capital Improvements. Increases in the quantity or quality of human capital, physical capital, economic capital, natural resources capital, social capital, cultural capital, and institutional capital.

Socially Sound: The social benefits of firms and public entities outweighs their social costs. Social Performance Measures are used to rate the social productivity and performance of firms and public entities. In the context of DevTreks, social soundness has to be defined in terms of costs, benefits, productivity, tradeoffs, and performance. When benefits can't be monetized, they

should be expressed in alternative ways –such as cost per QALY (quality adjusted life year) or per capita cost per unit decrease in emissions.

The Community. This is a general term used to loosely define the boundaries where Social Performance measurements take place. In the natural resources conservation area, these boundaries can vary from a local watershed to an entire ecosystem, In the case of climate change, "the community" is defined as the planet. In the context of this reference, this term reflects the reality that most resource conservation planning occurs in boundaries defined by political jurisdictions, including cities, counties, and states. In the case of a private sector firm, it's often defined in terms of market segments of consumers.

In the former case, the public sector entity carrying out a Resource Conservation Value Accounting assessment, is not a specific government agency –it's a team of specialists working for various government agencies. In the latter case, the public sector entity carrying out a Resource Conservation Accounting assessment, can be a specific government entity, such as an environmental protection agency. It can also be a political entity –a mayor's task force or a governor's establishment of a conservation technology assessment district.

Good Actors. Firms that care deeply about investor, customer, and informed citizen, demand for socially sound behavior. It's not unusual for these firms to go out of their way to attain 3rd party confirmation about the social soundness of their actions, goods, and services.

Bad Actors. Firms that don't privately care about investor, customer, or informed citizen, demand for socially sound behavior. It's not unusual for these firms to use their marketing departments and political lobbyists to try to mask the social unsoundness of their actions, goods, and services.

Good and Bad Actor Groups. Good and bad actors need not be individual firms or public sector entities. They can be defined as groups of good or bad actors by defining general characteristics that fit multiple firms or public entities. Their characteristics are defined in a way that allows citizens to easily identify the individual actors. Unlike many existing resource

conservation reporting systems, a major reporting goal is to transparently "point fingers" at these actors.

Informed Citizens. Voters who doubt the veracity of tabloid, television, and Internet reporting and take concrete action to educate themselves to discern good from bad, real from fake, and important from contrived. Their goal is to become fully productive members of society who can make life better for their children and their children's descendants. They are as concerned about having a well-paying job that can support their children as with having a planet and community that their children's descendants actually want to live on and work in.

Conserving Scarce Resources. In the context of this tutorial, the term "conserving scarce resources" has two meanings. In the Performance Analysis 1 reference, it primarily means presenting proof, in the form of traditional economic and technical measurements, such as Net Returns, of economically sound performance and productivity.

In the Performance Analysis 2 reference, it primarily means presenting public proof about a firm or public entity's claims about their impacts on the public services generated by public goods. Firms use the Social Performance Measures in this reference to gather and present public evidence about their claims about their social soundness. Social Performance Measures deal with public capital stock measurements that prove socially sound performance and productivity.

Social Performance Measures. Indicators, or Disclosures, used to quantify a firm or public entity's impacts on the public services generated by public goods.

Firms and public entities use Social Performance Measures that follow a Resource Conservation Value Accounting Framework as background evidence, or materiality, to support financial reporting claims about conserving scarce resources. Their goal is to actively contribute to balanced lives and a balanced planet. Investors, customers, and informed citizens use Social Performance Measures to take concrete action to support good actors and to chasten bad actors.

Resource Conservation Value Accounting (RCA). An accounting framework that uses Social Performance Measures to report on a firm or public entity's impacts on public goods. They

supply background evidence to support corporate and public entity financial reporting claims about the conservation of scarce resources. They help companies and public entities to actively contribute to balanced lives and a balanced planet.

Conservation Technology Assessment (CTA). CTA is the analysis of resource stock flows and balances, and conservation technologies that are designed to prevent or correct imbalances in the stocks.

The CTA definition uses the term *Conservation* in a general microeconomic sense –firms, households, and governments can improve lives and livelihoods by allocating scare resources well. The term *Technology* is also used in a general way –management practices, firm performance, projects, and policies are also assessed using CTAs.

CTA-Prevention (CTAP). CTAP is the numeric assessment of the costs and benefits of a portfolio of mitigation and adaptation interventions that prevent or correct resource stock damages. Assessments use relevant Conservation Technology Assessment (CTA) algorithms to quantify the risk and uncertainty associated with resource stock measurement and valuation.

Materiality. The following definition derives from the FASB: "Information is material if omitting it or misstating it could influence decisions that users make on the basis of the financial information of a specific reporting entity".

Indicator. Eurostat (2014) definition: "An indicator is defined as a statistical variable presented in the form of a time series and chosen to monitor the evolution of a specific aspect of the issue dealt with (e.g. the aspects of health, economic efficiency or natural resources for the issue of sustainable development) towards a desired direction or a target value. This understanding of the term 'indicator' corresponds to what is also called 'performance' or 'normative' indicators."

Indicator Assessment. Eurostat (2014) definition: "Indicator-based assessment refers to the positive, negative, neutral (or any intermediate class between 'positive' and 'negative') qualification of an indicator based on the comparison between its observed evolution (and/or status), and the desired evolution set for the indicator by means of a frame of reference."

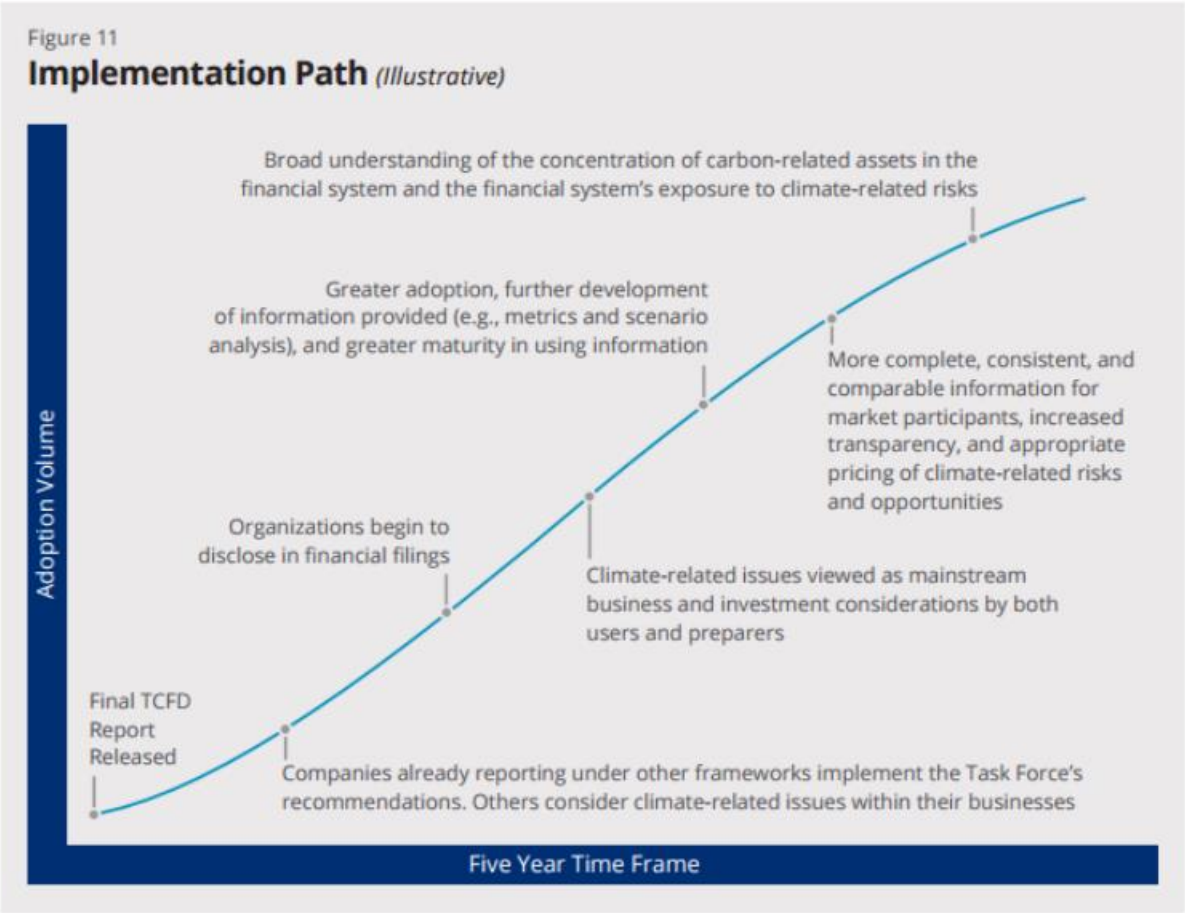
Indicator Thresholds. Eurostat (2014) definition: "Thresholds are needed to delimit the positive, negative and neutral qualification classes attributed to indicators by the indicator-based assessment process (comparison of the observed and desired evolutions). The definition of the thresholds depends on the type of assessment method chosen, in particular on how the desired and observed evolution are compared."

Transparent Proof. Scientific evidence that is completed online, stored uniformly online, and easily accessed online by people and machines. This proof is maintained in online knowledge banks and passed down to future generations.

Technology Development, Diffusion, and Adoption. Technological advances that improve worker and organization productivity result in better economic performance. These advances are the principle way that economic development takes place (**9***). In the context of corporate financial risks from climate change, the TFCRFD (2016) uses the following explanation to help define this term.

"Technological improvements or innovations that support the transition to a low-carbon, energy-efficient economic system can have a significant impact on organizations. For example, the development and use of emerging technologies such as renewable energy, battery storage, energy efficiency, and carbon capture and storage will affect the competitiveness of certain organizations, their production and distribution costs, and ultimately the demand for their products and services from end users. To the extent that new technology displaces old systems and disrupts some parts of the existing economic system, winners and losers will emerge from this "creative destruction" process. The timing of technology development [, diffusion, and adoption], however, is a key uncertainty in assessing technology risk."

That organization uses the following timeline, or technology diffusion and adoption path, to illustrate goals for corporate disclosure of the financial risks associated with climate change. A similar path is appropriate for the adoption and diffusion of the types of applied Social Performance tools introduced in this reference.



Public Capital Stock Resiliency measures the ability of a community to:

1. Identify, support, and learn from, the positive impacts to public capital stock services caused by sound private sector firm behavior and/or good public sector management.
2. Reduce exposure and sensitivity to, and recover and learn from, the negative impacts to public capital stock services caused by unsound private sector firm behavior and/or bad public sector management.

Please use Wikipedia's definitions of the following terms associated with public capital stocks. Feel free to contribute to those definitions. The Technology Assessment tutorials have examples and datasets that further explain these concepts. **Institutional Capital** is addressed separately because Wikipedia does not cover the topic.

Natural Resources Capital, Human Capital, Physical Capital, Social Capital, Cultural Capital, Economic Capital

Institutional Capital. In the context of Performance Analysis, the following image provides the intended context for this term. The author built this image about a decade ago to summarize Douglass North's theory of "adaptive efficiency", as defined next, and to understand economic performance and development better. That Nobel laureate's publications, such as "Transaction costs, institutions, and economic performance" and "Understanding the Process of Economic Change", cover this topic in greater depth. Summaries can be found on amazon. Examples of formal institutions include laws and regulations. Examples of informal institutions include social norms and shared beliefs (refer to the Levitsky and Ziblatt reference (NYT, 2016) for a concrete example of the importance of informal institutions).

In the context of the applied RCA Framework introduced in Appendix A, the IPCC WG2 reference provides several good contextual overviews of the fundamental role of Institutions in protecting and improving resource stocks and their services (i.e. Sections 2.2.2, Institutional Context, and 20.4.2, Assuring Effective Institutions in Developing, Implementing, and Sustaining Resilient Strategies). Appendix 1 in the IBPES (2016b) references also gives a formal definition of the term and demonstrates the central role played by this capital stock in conducting thorough capital stock assessments. A key contribution this reference makes to this definition is to put cloud-based IT companies at the forefront of institutional capital improvement.

Adaptive Efficiency. A theory of societal change, coined by Douglass C. North, that attributes successful economic change to human effectiveness in adapting formal rules and informal norms (i.e. institutions) that constrain their behavior towards productive outcomes. Adaptive efficiency describes society's ability to create institutions that have the responsiveness to change course (i.e. beliefs and created institutions) when outcomes deviate from intentions.

History is full of examples where good human intention led to unexpected, and disastrous, outcomes. Good institutions reduce the gap between intention and outcome. They do so by increasing the stock of knowledge that helps people to predict outcomes and make willful

decisions to use this knowledge to improve their lot. Adaptive efficiency explains the manner by which humans develop rules, beliefs, behaviors, and customs that support productive outcomes. Good institutions come about by adapting to solve new problems, learning from past mistakes, filtering out bad information, and reducing the uncertainty of outcomes. They tend to evolve slowly, learning step-by-step, making incremental progress, adapting to changing circumstances, gaining credibility, and eventually improving society.

Adaptive Management. Adaptive Management is defined by PR&G (2013) as "Adaptive Management is a deliberate, iterative, and scientific based process of designing, implementing, monitoring, and adjusting an action, measure, or project to address changing circumstances and outcomes, reduce uncertainty, and maximize one or more goals over time."

Stock of Knowledge
•Human capital
•Inherited customs (ideas, values, norms)

Beliefs
•Role of science
•Role of government
•Role of citizen
•Role of religion

Institutions Created
•Political (i.e. property rights)
•Social (i.e. community group rights)
•Economic (i.e. market support)

Outcomes
•Intended vs. Actual
•Consequences

Lessons Learned
•Performance Metrics (higher productivity, lower transaction costs, success in getting things done, changed beliefs, changed institutions

New and Better Stock of Knowledge