Examing the impact of GHG accounting principles

Michael Gillenwater
Greenhouse Gas Management Institute, Seattle, Washington, USA

ABSTRACT
Clearly defined principles are essential elements of GHG accounting and reporting guidelines, protocols, and standards to address the unavoidable expert judgments that must be applied to address ambiguities in these documents. The IPCC guidelines identify transparency, accuracy, completeness, (time series) consistency, and comparability as its foundational data quality principles. The principles of conservativeness, relevance, and comparability see varied use across major GHG accounting references. These differences in principles, especially with respect to the principle of comparability, indicate there are underlying problems with many GHG accounting protocols and standards now heavily referenced and applied.

Introduction
When performing greenhouse gas (GHG) accounting work, such as preparing an emission inventory or assessing an emission reduction project, you will, at some point, need to apply expert judgment. You may need to make assumptions to fill gaps in activity data or modify an emission estimation methodology to account for process conditions not anticipated by a default methodology or emission factor. The IPCC Guidelines for National GHG Inventories, a founding document within the GHG accounting field, recognizes this need. Lead authors of the Intergovernmental Panel on Climate Change’s (IPCC’s) methodology reports have achieved consensus on a set of precisely defined quality principles; transparency, accuracy, consistency, completeness, and comparability [1].

Unfortunately, no guidance document anticipates every possible technical issue. It is during these moments that experts must refer to GHG quantification and accounting quality principles. It is easy to forget about something as fundamental as quality principles or dismiss them as merely suggestions. However, well-defined principles are a touchstone to steer and justify expert judgments.

When you do spend time with the quality principles elaborated in various GHG accounting references, you notice that there are discrepancies in what principles are recognized and how they are defined across protocols, standards, and guidelines. Table 1 [1–8] shows the differences in quality principles across major GHG accounting references. Table 2 [1–9] details the type of environmental accounting method each GHG accounting reference addresses.

Transparency, accuracy, completeness, and consistency
Transparency should be seen as a meta principle. Without transparency—through the disclosure of GHG accounting data inputs, methodologies, and assumptions—none of the other data quality principles can express themselves. Unsurprisingly, all major GHG accounting protocols, standards, and guidelines include this principle (see Supplemental materials for definitions of principles used in each major GHG reference) [1–8]. The critical importance of transparency can be seen clearly in how the definitions of other principles reiterate or repeat the need for transparency.

Similarly, all of these protocols, standards, and guidelines follow the IPCC’s and UNFCCC’s good practice lead for making judgments and include the principles of accuracy (i.e. minimization of estimation uncertainties), completeness (i.e. avoiding omissions and double counting in estimates), and consistency in the time series of estimates prepared [1–8]. These are each unarguably sound principles to aspire to regarding the quality of GHG emission and removal estimates done repeatedly over time.

Unfortunately, the word “consistency” leads to some confusion with other colloquial uses of the term and is used in an ambiguous manner by some GHG references (see Table 1 [4]), including being mistaken for a meaning similar to the principle of comparability. Properly stated, consistency is limited to the concept of achieving a consistent time series of data across years or other frequency of estimation. This quality principle is applied internally to a sequence of GHG inventories and/or estimates for a single entity or jurisdiction. Technically
choices on which firms are achieving superior reports that are contingent on estimates across companies, that sum to the system-wide total. They produce emission estimates for a population of entities at attributional GHG accounting methods, as they should produce comparable results that can support — and standards. The IPCC 2006 Guidelines for national GHG inventories — universality included as a principle across GHG protocols and standards. The IPCC 2006 Guidelines for national GHG inventories [1] includes comparability, yet why have most other major GHG accounting references neglected this obviously fundamental principle [2–8]? It is odd to imagine any proper “standard” that does not have as its fundamental purpose the establishment of practices that produce comparable results across entities applying that standard. Is that not the core function of standardization — replicable results that can support comparability or interoperability? Put simply, by comparable we mean that the emission estimates produced for an entity (e.g. a facility, company, city, country, project, policy, or product) can be compared to estimates produced for other entities applying the same standard. The meaning of this principle is especially germane for attributional GHG accounting methods, as they should produce emission estimates for a population of entities that sum to the system-wide total. There are numerous uses of corporate GHG inventory reports that are contingent on estimates across companies being comparable. Specifically, the proposition of using reported corporate disclosures to inform investor’s choices on which firms are achieving superior performance with respect to their GHG emissions presume disclosed estimates are comparable between companies. Yet, the protocols and standards used by corporations for estimation and reporting do not even include comparability as an explicit objective. Instead, it is knowingly excluded as a principle. Can the design of a GHG protocol or standard not pursue the production of comparable estimates and still be meaningful for most decision-making applications? What rationale justifies the enormous attention given to preventing double counting between corporate emission inventories (e.g. scope 1, 2, and 3 emissions) that are not comparable across companies in the first place? If we agree that climate actions will suffer if they are built upon misleading GHG accounting, then we need more precision regarding the application of GHG standards. Most GHG standards and protocols express that they present a standard that has broad policy and practical applicability, but the result instead is an illusory and false form of standardization. It is unrealistic to expect a “standard” to be so widely applicable that even the limits of that applicability are unspecified and unknown, as currently the case. Ironically, out of this group of GHG accounting references, despite not calling it a “standard,” it is only the IPCC guidelines that fosters standardization by giving careful attention to comparability [1]. The other GHG references in Table 2 are better regarded as highly flexible guidance. I suggest that the absence of “comparability” offered by these other protocols and standards is at the root of many serious GHG accounting missteps and problems. In the context of consequential environmental accounting methods, “comparability” is a more nuanced

| Table 1. Quality principles included in select major GHG accounting references. The definitions of the principles in the included GHG accounting references can be found in Supplemental materials [1–8]. |
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| Quality principle | IPCC guidelines | ISO 14064-1 | GHGP corporate | GHGP cities | GHGP products | ISO 14062-2 | GHGP project | GHGP policy |
| Transparency | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| Completeness | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| Consistency | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| Accuracy | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| Conservativeness | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| Relevance | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| Comparability | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |

*Adopted by most voluntary GHG offset programs (e.g. Verified Carbon Standard).
**Does not distinguish the concept of comparability across emission inventories, but instead blurs the concept with time series “consistency” for an individual inventory.

This GHG Protocol reference is equivocal as to the inclusion of “conservativeness” as a principle. It is listed separately from other principles in a text box.

| Table 2. Details on select major GHG accounting references [1–9]. |
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| Brief name | Reference | Type of environmental accounting |
| IPCC guidelines | IPCC guidelines for national GHG inventories (1995, 1996, 2000, 2003, 2006, 2019) | Attributional at national level |
| ISO 14064-1 | ISO 14064 - Part 1 (2006, 2018) | Attributional at organizational level |
| GHGP corporate | GHG Protocol Corporate Accounting and Reporting Standard (2001 and 2004) | Attributional at organizational level |
| GHGP cities | Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (2014, 2021) | Attributional at the sub-national jurisdictional level |
| GHGP products | Product Life Cycle Accounting and Reporting Standard (2011) | Attributional at product level |
| ISO 14064-2 | ISO 14064 - Part 2 (2006, 2019) | Consequential at project level |
| GHGP project | GHG Protocol for Project Accounting (2005) | Consequential at project level |
| GHGP policy | GHG Protocol Policy and Action Standard (2014) | Consequential at policy level |

*Typologies of environmental accounting frameworks are typically described by their methodological accounting approach and estimation boundary [9].
concept. It is desired in contexts where a policy or other decision involves a range of GHG mitigation options. The impact assessment of each option should be comparable to support project, policy, or action decision-making. Yet, you would not expect, or even necessarily desire, comparability of impact assessments across different decision-making cases. So, the principle applies within the bounds of comparing options for a single mitigation intervention (e.g. for one emission source on a single site) or policy decision (e.g. nation-wide building sector regulation).

Conservativeness

An interesting addition you may encounter when using some GHG accounting protocols and standards that entail consequential GHG accounting methods is the principle of estimation "conservativeness." On the surface, the principle seems reasonable, especially in the context of quantifying GHG emissions reduction benefits. We typically do not want to over-credit the estimated impact of an intervention, especially if that credit is being used to claim an offset against some other environmental harm. Yet, logically, there is an incongruity between this principle and "accuracy." The practical application of conservativeness entails the intentional biasing of quantitative estimates such that they deviate from the most accurate (i.e. statistically unbiased) estimate. At least most GHG protocols and standards that apply consequential GHG accounting methods acknowledge this contradiction, given that they include both principles [6–8].

I would argue that rather than specifying "conservativeness" as a distinct GHG accounting principle—thereby placing two principles in zero sum conflict—that conservativeness should be addressed as a policy design consideration within each GHG program or regulation (i.e. whether, how, and to what magnitude conservativeness is integrated into specific rules and methodologies) rather than a data quality principle. GHG emission and removal estimates should not be biased, and thereby made intentionally inaccurate. Conservativeness can instead be applied through transparent adjustments and other program rules in keeping with the intended users' needs and expectations. It is justified to be concerned about the uncertainty in estimated emission reductions when issuing credit for that performance, and therefore seek to be "conservative." However, in combination, the principles of "transparency" and "accuracy" should already be understood to compel the open disclosure of uncertainties regarding the quantification of GHG emission reduction impacts.

More fundamentally, "conservativeness" stands out as an exceptionally awkward, and probably improper, data quality principle. Holding all other factors constant, all other principles represent characteristics one should strive to maximize (e.g. more accuracy is good, more time series consistency is good, and more completeness is good). In contrast, more "conservativeness" is not an objectively good characteristic for data to exhibit. You may aim for the appropriate amount of conservative bias in estimates, which in some cases may be none, but you would never aim to maximize bias!

Relevance

The principle of "relevance" is included in most major GHG accounting protocols and standards, but not in the IPCC Guidelines [1]. On first inspection, this principle seems obvious. Of course, we do not want our GHG emissions estimates to be irrelevant. It stands to reason that if one goes to the effort of preparing an emissions inventory or quantifying an intervention’s emission reduction impacts, the resulting data should be relevant to the intended users of those results. So, why have most GHG protocols and standards decided it was necessary to add this obvious concept to their list of principles while the IPCC did not? Again, each of the other GHG references attempt to provide flexible guidance for any application of their targeted type of environmental accounting data (i.e. they strive for policy and program neutrality) [2–8]. In doing so, they are excessively vague as to application limitations (i.e. how their resulting estimates will or should be used as well as not used).

Although the IPCC guidelines provide meaningful methodological flexibility, this broader application ambiguity does not exist within the IPCC guidelines, which have a well-understood application—compliance reporting of GHG emissions by nation states under international treaties. The relevance of the IPCC Guidelines is, by design and made explicit. In contrast, it is only hoped that the data produced under these other these GHG protocols or standards will find constructive applications. I would argue that a well-constructed protocol, standard, or guideline should also, by design, be relevant and should patenty specify how the resulting estimates produced under it are to be used. The serious problems arising from the application ambiguities in these GHG references are unlikely to be compensated for by attempting to remind users that they should avoid relying on irrelevant results. Unfortunately, the wishful thinking appeal of the "relevant" principle reminds me of the historic use of the term "real" as a meaningless, yet feel-good, carbon offset quality criteria [10].

Conclusions

Despite the seemingly mundane and pedantic nature of GHG accounting principles, they have far-reaching effects on GHG policies, programs, and environmental markets. Like many professions, GHG accounting practitioners’ deepest intentions are found in the principles and norms they adopt. As you may suspect, I favor the principles and definitions stipulated in the IPCC guidelines [1]. Although not perfect, they are presently the most thoughtfully, discretely, and carefully elaborated. There are still much works to do with respect to making the principles of other existing GHG protocols and standards as meaningful. Each of them would be wise to reconsider whether they have sufficient justification for augmenting or diverging from IPCC’s good practice model. I, for one, do not see any compelling justifications.
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ORCID

Michael Gillenwater http://orcid.org/0000-0003-4285-7806

Data availability statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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