Making world hunger legible

The politics of measuring global food insecurity

Thor Olav Iversen

Thesis for the degree of Philosophiae Doctor (PhD)
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Abstract

Indicators of food security and nutrition are among the most central indicators informing the international development agenda. The literature on the historical, conceptual, and political aspects of measuring hunger is however scarce. This thesis addresses this knowledge gap by investigating how global statistics on food security and nutrition are embedded in the political landscape that surrounds them. It does so by means of homing in on two model-based indicators developed and published by the United Nations (UN) and integrated in the Sustainable Development Goals (SDGs).

The indicator Prevalence of Undernourishment (PoU) is the UN and Food and Agricultural Organization's (FAO) traditional flagship indicator on world hunger. The thesis chronicles and analyzes the development of its statistical model since 1946 as well as the political and historical context of its revisions. It shows that technical revisions that have led to substantial changes in the estimates of the indicator have underpinned shifting policy narratives about trends in the fight against hunger. A key example is the revisions undertaken as the Millennium Development Goals (MDGs) were coming to an end and it was time to judge progress. Trend lines showing crises and a decades-long rise in undernutrition were entirely discarded by technical adjustments that bolstered a narrative of global progress in the era of the MDGs. Access to new survey data from China in 2020 enabled FAO to provide verification of the Chinese government's narratives of social progress. Times of crisis have furthermore necessitated ad hoc technical revisions to show that more people go hungry during periods of drastic food price inflation, global pandemics, or economic recessions. These revisions highlight the need for greater transparency and facilitation of

reproduction of results in the data and modelling basis for the PoU.

The second indicator chosen to monitor SDG Target 2.1 is the household level experienced-based food security indicator Food Insecurity Experience Scale (FIES). While there was significant contestation around which indicators should be selected for the SDGs, the process was characterized by pathway lock-in: The complexity of food security quantification favored already established data infrastructures and milieus of expertise, locking in the position of FAO and its established food security indicators. Key enforcers of this path dependency were resource constraints and limited availability data, as the chosen FAO indicators were among few options with well-established global data infrastructures. The resulting SDG 2.1 indicators frame food insecurity in terms of caloric supply and demand and individual experience, arguably excluding dimensions of democratic agency, sustainability and other dimensions and drivers of food insecurity.

The SDG process furthermore purports to separate politics and technical matters, embodied by the *political* negotiation of goals and targets, and the *technical* creation of an indicator framework. The narrative of separation between the technical and the political process built into the SDGs is reproduced by the statisticians tasked with crafting its indicator framework. A side effect of the attempt to clinically divide the SDGs into parallel political and technical processes is that contestation about indicators that are highly political in nature is disregarded because it is considered inappropriate in a technical body. In this thesis, I argue that development processes would benefit from more diverse indicator bodies than the current Inter-agency and Expert Group on

SDG indicators (IAEG-SDGs) through including relevant expertise from a broadly defined civil society. Such diversification could explicate already existing political and value contestations, rendering them more transparent and visible to the public. It may also contribute to capturing more of the complexities of sustainable development in future monitoring frameworks through consideration of a broader selection of indicators and methodologies.

I also argue that considering the knowledge politics of indicators is important to broaden and open agendas for sustainable transformations of food systems. Indicators that monitor their success should not be chosen due to the dominance of certain incumbents and their data infrastructures but rather reflect democratically set priorities. Highlighting additional aspects of the multidimensional concept of food security through statistics is crucial in this endeavor. We therefore need a greater diversity of measurement approaches and data infrastructures.

Oppsummering

Indikatorar for mattryggleik og ernæring er blant dei mest sentrale måleinstrumenta for internasjonal utvikling. Forskingslitteraturen kring historiske, konseptuelle og politiske dimensjonar ved måling av svolt er likevel atterhalden. Denne doktorgradsavhandlinga freistar å fylle eit tomrom ved å undersøke korleis global statistikk på mattryggleik og ernæring er knytt saman med det politiske landskapet som omsluttar dei. Dette gjer den ved å studere to modellbaserte indikatorar som har blitt utvikla og publisert av Dei sameinte nasjonar (SN) og er integrerte i Bærekraftsmåla (SDGane).

Indikatoren Prevalence of Underourishment (PoU) er SN-systemet og særleg Food and Agricultural Organizations's (FAO) sin flaggskipmetode for å måle global svolt. Avhandlinga skildrar og analyserer utviklinga av den statistiske modellen som PoU baserer seg på sidan 1946 og fram til i dag. Ho syner især korleis ei rekke tekniske endringar har støtta opp om omskiftelege narrativ kring politikk og styring i kampen mot svolt. Eit nøkkeldøme er endringane som vart utførte etterkvart som Milleniumsmåla (MDG) gjekk mot slutten og FN skulle vurdere internasjonal framgong. Trendliner som frå før av synte krise og konsistents auke i undernæring sidan starten av nittitalet vart erstatta av nye estimat som styrka eit motsett narrativ om global framgong i MDG-perioden. Ny tilgong til spørjeundersøkingar frå Kina i 2020 tillot også FAO å gi indirekte verifikasjon av kinesiske styresmakter sine fortelingar om sosial framgong under autoritært styre. Ei rekke meir og mindre vilkårlege tekniske revisjonar har også vore utførte i krisetider for å få PoU sine estimat til å syne auke i svolt under pandemi, økonomisk resesjon og dramatisk matvareinflasjon. Desse revisjonane syner behovet for større gjennomsiktigheit og tilrettelegging for reproduksjon av estimat i dataen og modelleringen til PoU.

Den andre indikatoren som har blitt valt for å måle bærekraftsmål SDG 2.1 er den erfaringsbaserte mattryggleiksindikatoren Food Insecurity Experience Scale (FIES). Det var mykje usemje kring kva indikatorar som burde bli valt for å måle SDG 2.1, men prosessen var likevel prega av stiavhengigheit: Kompleksiteten i å kvantifisere mattryggleik favoriserte datainfrastrukturar og ekspertisemiljø som allereie vart etablerte, og låste FAO sine etablerte indikatorar i posisjon. Nokre nøkkelfaktorar i denne stiavhenigheiten er avgrensa ressursar og tilgjenge av data, ettersom FAO sine indikatorar var blant få alternativ med globale datainfrastrukturar. Indikatorane for SDG 2.1 definerer mattryggleik ut frå tilbod og etterspurnad etter kaloriar samt individuell erfaring, og ekskluderer med difor demokratisk medverknad, bærekraft og andre dimensjonar og drivararar av mattryggleik.

SDGane er bygde på eit skilje mellom politiske og tekniske prosessar, lekamleggjort av ei *politisk* forhandling om måla, og ein *teknisk* prosess for å lage eit målstyringsrammeverk med indikatorar. Dette narrativet om klare skilje mellom teknikk og politikk vert reprodusert av statistikarane frå nasjonale statistikkbyrå som skal lage indikatorrammeverket. Ei bivirkning av denne inndelinga er at legitim usemje om indikatorar vert avfeid fordi den vert rekna som politisk. I denne avhandlinga argumenterer eg for at det er mykje å tene på å inkludere meir variert ekspertise i prosessar for å lage indikatorrammeverk for bærekraftig utvikling. Dette gjeld særleg ekspertise frå eit breitt definert sivilsamfunn. Ei slik diversifisering kan gjere ulike syn på verdiar, vitskap og politikk meir synlege for offentlegheita. Den kan også bidra til å fange meir av kompleksiteten i bærekraftig utvikling gjennom vurdering av eit breiare utval med indikatorar og metodologiar.

Det er viktig å halde fram med å ta føre seg dei kunnskapspolitiske aspekta ved indikatorar på mattryggleik og ernæring for å opne opp agendaen for bærekraftig utvikling av matsystem. Indikatorar som skal måle oppnåing bør ikkje bli valte på grunnlag av dominansen til enkelte organisasjonar, og deira datainfrastrukturar, men snarare reflektere demokratiske prioriteringar. Å kaste lys over fleire aspekt ved det multidimensjonale konseptet mattryggleik gjennom statistikk er viktig for å få til eit slikt skifte. Vi behøver difor ein større variasjon av målemetodar og datainfrastruktur.

List of Publications

Article 1:

Iversen, T.O., Westengen, O. & Jerven M. (2023). *The history of hunger: Counting calories to make global food security legible*. Accepted for publication in *World Development Perspectives*.

Article 2:

Iversen, T.O., Westengen, O. & Jerven M. (2023). *Measuring the end of hunger: Knowledge politics in the selection of SDG food security indicators*. Published in *Agriculture and Human Values* (2023): 1-14.

Article 3:

Iversen, T.O. (2023). *Defending a technical space: Science and politics in measuring the SDGs*. In review after resubmission to special issue of *Global Policy*.

Preface

This doctoral dissertation is inexorably linked to my personal experience as a humanitarian aid worker in the United Nations World Food Programme (WFP). The project idea took form during my work with humanitarian food aid at the WFP Regional Bureau for the Middle East, Eastern Europe, and Central Asia. Working within these emergency and conflict contexts sparked an interest in how we as aid workers and humanitarians render the world *observable* through science. This interest in understanding how agencies who manage and distribute food aid observe and act in the world has been a motivating factor throughout the PhD.

The dissertation is a testament to the potential usefulness of professional and practical (not exclusively academic) experience in doing theory of science. When studying a science that is intimately connected with specific profession (such as medicine, psychology or in my case aid work), practical and professional experience can sensitize researchers to scientific problems that are less visible through academic training and research. The understanding of the global food security situation, food security as a concept, as well as the political economy of food aid and food security quantification gained through this work has been seminal to the project. It is indeed difficult to imagine that the project could have been conceived without it.

Some sciences, such as accounting and insurance, have arisen as practices and professions before emerging as academic disciplines (Porter, 1995). This is to a great extent also true of statistics, which has throughout much of human history been a profoundly administrative activity (Desrosières, 1998). As a modern science, it has furthermore been shaped by the efforts of activists, humanitarians, and citizen scientists (Anderson, 1997; Bruno et al., 2015; Hacking, 1990; Riley, 1911). I was introduced to statistics during my training in economics, a discipline which in its current form is almost entirely focused on quantitative methods. Through experience as a development economist at Chr Michelsen Institute (CMI), and engaging with the work of my supervisor Morten Jerven (2013), my interest in the statistics of the development field was sparked.

It would be easy to equate the fact that quantification of nutrition and food security is in general very difficult (and much more so at the global level) due to the inherent complexity of food security and nutrition, with a lack of skill or reflexivity on behalf of its practitioners. I remain convinced that many statisticians are aware of limitations and pitfalls in the current methods of measuring global food security and nutrition. I do, however, hope that this dissertation can provide some useful insights and questions for practitioners, while shedding light on the history as well as political and conceptual aspects of a scientific discipline that is important in and of itself.

My professional experience has led me to believe that food security quantification is not trivial but is in fact important - in the sense that it can affect the lives of individuals that depend on food, agriculture, and nutrition policies. I still think so, but exactly where it fits in a hierarchy of social importance is a discussion that I will leave up to others to have. At the start of 2023, it does however seem uncommonly easy to argue that how we choose to render food security visible is important: We live in a time where hunger is used as war's perhaps most deadly weapon. Hundreds of thousands of civilians have been willfully depraved of food and other objects that are indispensable to their lives out of strategic considerations and perhaps even genocidal intent (IPC, 2021; Plaut, 2022). Meanwhile, a global pandemic has worsened the food security of millions of individuals (FAO et al., 2021), and food price inflation has skyrocketed following all-out war between nation states (UN, 2022). WFP aimed to provide food aid to 140 million people in 2022, up from 116 million in 2022 (Fujita, 2022).

The use of hunger as a tool of war has been a priority of mine to communicate during the project through public writing, particular in the context of the famine in Yemen (Iversen, 2021a, 2021b). As both an academic, former humanitarian and human being, my heart bleeds for victims of both chronic hunger and it's use as a deadly and disabling weapon. Although not sufficient on its own, I nevertheless hope to continue to shed light on the humanitarian technologies used to render hunger and depravation legible also after I defend my dissertation.

Introduction

In a recent landmark report on the state of global food insecurity, the directors of five United Nations (UN) agencies announced that the "*challenges to ending hunger, food insecurity and all forms of malnutrition keep growing*" due to upheavals in international food markets (FAO et al. 2022, p. vii). How such food insecurity and malnutrition is measured is increasingly important for how we in turn act to alleviate hunger (HLPE-CFS 2022). This thesis investigates how such statistics intertwine with politics, in the sense of values, interests and norms. It does so by means of homing in on two model-based indicators developed and published by the UN. These indicators have been chosen because they are embedded in the UN Sustainable Development Goals (SDGs), which is a crucial and contemporary global policy framework (Dodds, Donoghue, and Roesch 2017).

According to the UN world hunger is rising (FAO et al. 2022), with historically high levels of food insecurity predicted (Economist 2022). The invasion of Ukraine and the following food shortage hit an international food system that was already severely weakened by the covid-19 pandemic, energy shortage, and climate change. Prices for essential foodstuffs such as wheat and sunflower skyrocketed after the curtailing of exports from Russia and Ukraine, which provide a substantial amount of the traded calories to world markets. In May of 2022, UN Secretary-General António Guterres remarked that "*we face the spectre of global food shortage*" which could last for years (UN 2022).

This turmoil in world markets came on top of an already serious situation: The FAO Food Price Index had already reached its highest level ever at the start of the invasion of Ukraine in February of 2022 (FAO 2022). Despite cooling international food inflation over the last months, the situation remains precarious. WFP in August 2022 warned that the global food security situation was going from "*bad to worse*", due to droughts across the globe caused by climate change (Fujita 2022). The Horn of Africa was meanwhile undergoing its most severe drought in decades, with declaration of famine considered for Somalia (IPC 2022). Ethiopia was for most of the year in the grips of a faminogenic civil war that may amount to genocide (Ibreck and de Waal 2022; Marcus 2003).

How we measure hunger matters because it impacts how we perceive it as a problem as well as how we conceptualize its solutions. A primary way to make hunger visible to society, policymakers and scientists is through quantification: Measuring how many people lack food or experience inadequate nutrition. It is particularly challenging to quantify food security because of its complexity. It is a concept that in its most common version contains several dimensions that cannot all be adequately captured in one number (WFS 1996; HLPE-CFS 2020).[1] Choosing a specific way to quantify food insecurity will therefore always involve making trade-offs.

[1] Food security indicators may focus on food *availability* (adequate food supplies for a given population), *access* (ability to access available food), *utilization* (nutritional intake and absorption), *stability* (over time), or a combination of these (Jones et al. 2013; Upton, Cissé, & Barrett, 2016). Recently, the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security (CFS) proposed to update the definition to also include the dimensions *agency* (decision power) and *sustainability* (environmental resilience) (HLPE-CFS, 2020).

More generally, science always entails forms of idealization and reduction of the inherent complexity of reality (Skirbekk 2020; Strand 2019; Mitchell 2009; Meadows 1999). Studying the ways in which science simplifies and reduces the complexity of reality is therefore crucial, also when it comes to statistics on nutrition and food security. The immense impact of statistical science and thinking on modern societies is well documented (Hacking 1990; Lie and Roll-Hansen 2001; Porter 1995; Porter 2020). Part of this impact comes from the ever-present tension between construction and representation of reality that is inherent in statistics (Desrosières 1998). It is therefore important to do research on statistics that not only emphasizes its technical aspects, but also pays attention to the particular ways in which it represents and constructs the world. This thesis is therefore not only concerned with the technical features of global statistics on food security and nutrition, but also its underlying concepts, history, and politics.

The following sections are included in this introduction (*kappe*): In this first section, I introduce the project and the research question(s) of the thesis. Second, I present the methods and methodology employed in the thesis. Third, I outline the most important findings of the dissertation. Fourth, I discuss the different theoretical traditions and concepts that I have engaged with in the research articles. Fifth, I respond to the primary research question. After the *kappe,* the research articles of the dissertation follow.

1.1. Studying statistics on hunger

This thesis places itself at a cross-section between the study of development and science. As such, it can be situated in a context of *development studies.* Development studies is an interdisciplinary and normative field that revolve around processes of social change (*development*) often focused on low income countries, where middle and high income countries take on a more ambiguous role (Sumner 2022). The empirical context of this dissertation is global statistics on hunger. These types of statistics are particularly relevant for, and mainly used in, policy and science pertaining to development aid. Development is, however, a contested concept. This is also reflected in the different academic traditions that constitute development studies (Kvangraven 2021).

This project is particularly adjacent to *global development studies* in the sense that it is concerned with global statistics and measurements that are used to render international food security legible (Horner and Hulme 2019). It starts with an understanding of development as independent of resources or income. The SDGs, which defines development as a process pertaining to all countries, is an empirical focus. The project also takes cues from *critical development studies*, in the sense that it engages with the values, norms and theories embedded in knowledge from the development field (Sumner 2022, p. 9).

This is, however, a dissertation in the field of *theory of science* (*vitenskapsteori*). It can be defined as a Scandinavian brand of *science studies* that combines philosophy, history and sociology of science with science policy studies and research on ethical aspects of science (Strand 2019). Science is in this context interpreted in a broad manner to include the humanities, arts, and social sciences. Theory of science is thus a field of interdisciplinary meta-research that combines methods and perspectives from a wide range of academic disciplines (Skirbekk 2020).

Skirbekk (2020) suggests that researchers in theory of science do engage with three aspects, all linked to *reflexivity* (Bourdieu 2004). One of them is how *power* is embedded and wielded in processes of science and expertise. Economic and political agents can be interested in influencing, emphasizing, and downplaying academic research. Adding to this, some disciplines may conceive a political or economic question in a way that is more beneficial to certain actors, as different disciplines use different conceptualizations that let us see different aspects of the same phenomenon. Human beings are furthermore self-interpreting creatures that influence each other through social interaction, and may therefore be influenced by the way they are conceptualized and described through science (Hacking 1986). Theory of science thus has a strong normative democratic motivation in seeking to open up "*black boxes of expertise and thereby rendering it accountable*" (Strand 2019, p. 6), constituting a "*vehicle for democratic development in a modern, differentiated society*" (Strand 2019, p. 10). This notion of the potential benefits of rendering science and expertise democratically transparent and accountable is a normative starting point for this thesis.

The second point is *certainty*, in the sense that scientists can face incentives to and sometimes do oversell their results (Skirbekk 2020). At the same time, laypeople can have too high expectations of certainty in science. Showcasing results characterized by artificially high certainty is problematic insofar as it creates high expectations in society for certainty, simplicity (as opposed to complexity), linearity and predictability in the systems that are studied by science.

The third point is *perspectivity*. Students, scientists, and society should learn that models are not reality and that disciplines are constructed perspectives whose representation of the world is mediated through built-in assumptions, norms, and values. The models they use are not reality, but rather an imperfect, limited representation of it. A lack of awareness of one’s own discipline-based perspective and what it can make us see and not see leads to a lack of epistemic humility and self-awareness rooted in a narrow disciplinary perspective.

Opening the black boxes of science is particularly important in technical areas such as statistics. Techniques such as statistical modeling are out of reach for people without extensive and specialized training, rendering it unintelligible and non-transparent to a large majority of citizens and decision-makers. As numbers are often framed as objective, universal and timeless (Porter 1995; Merry 2016), their prominence in science can close down potential avenues for critical engagement and democratic debate.

Quantification is never a neutral act, and has inherent effects on both knowledge and politics (Merry 2016). It is deeply intertwined with dominant power structures in contemporary society (Zuboff et al. 2019; O'Neil 2016; Saltelli et al. 2021; Zuboff 2015). Magnitudes that are measured are rarely pre-given, but require stabilization, simplification and standardization (Fjelland 2021; Desrosières 1998). Numbers therefore work best if what they represent can be remade in their image (Porter 1995;

Thévenot 2022). Due to the endless variation of nature and human beings, the objects of counting and quantification necessarily have to be forced into equivalents (Desrosières 1998). Quantification thus entails intervention at multiple levels.

As pointed out by Saltelli (2020), a field that critically investigates quantification should indeed include simple indicators that are already covered in a broad interdisciplinary literature (Berman and Hirschman 2018; Espeland and Stevens 2008), but it should also, importantly, include more intricate technologies such as statistical modelling and algorithms used in artificial intelligence. I support the sentiment that this empirical breadth is needed to think critically across different modes of quantification (Saltelli 2020; Saltelli et al. 2021; Saltelli and Di Fiore 2023). This thesis should therefore be read as an argument for critical studies of complex technologies of quantification.

It also serves as an example of the intellectual horizons opened by such a broad programme of critical research on quantification. The research articles focuses on the Food Insecurity Experience Scale (FIES) and Prevalence of Undernourishment (PoU), which are often referred to as indicators. However, as shown in the articles, they rely on complicated probabilistic modelling. Investigating these technologies that influence how we perceive and act upon world hunger would not be possible if I restricted myself to indicators that perform simple counting or qualitative ranking. My ambition is to analyze and translate the workings and underlying theories of these complicated scientific tools to democratic and academic publics.

1.2. Locating research gaps: Extending political agronomy

The empirical literature on the historical, conceptual, and political aspects of measuring hunger is limited to a handful of publications. I will now provide a short review of the relevant literature. Fukuda-Parr and Orr (2014) discuss the PoU's role as an indicator for the Millennium Development Goals, offering both conceptual and historical critiques. Pogge (2016) critiques how the goal posts have moved in terms of global goals for hunger and food security in the MDG era. An article by McNeill (2019) analyzes the work of FAO and other actors in trying to define and construct an indicator for sustainable agriculture in the SDGs. Lappé et al. (2013) encourages FAO to develop indicators that measure a wider concept of food insecurity than the PoU. Heinen (2022) outlines the recent history of agricultural statistics in Rwanda, and compares different data series and trend lines to expose consistent overestimation of agricultural output. Scott-Smith (2020) provides a historical account of how statistics have developed in tandem with food aid, with a particular emphasis on the development of anthropometric indicators. Vernon (2007) details the emergence of nutrient measurement and dietary survey data at the start of the 20th century.

The most adjacent empirical work to this dissertation may by virtue of its empirical emphasis be an article published by Ilcan and Phillips (2003) on FAO's statistical work at the time of the organization's establishment in 1945. It outlines a focused historical account of FAO's work on agricultural censuses in the postwar era. Furthermore, the historicization of the nutritional science as a whole has been regarded as insufficient (Nelson, Nisbett, and Gillespie 2021). It may have been neglected because nutrition sits in-between fields that have received more historical attention, such as international development, humanitarian aid, public health, medical research, and agricultural development.

Hitherto, then, there has been no attempt to present a holistic account of the development and impact of methods of measuring food security and hunger. This stands in a contrast to literature on the history of poverty measurement, which has been the subject of significant scholarly attention (Jerven 2018; Ravallion 2015), that may be explained by the centrality of poverty to the development agenda (Sumner 2022). This thesis tries to fill in a space in this gap by analyzing global measurement of food security and nutrition.

The thesis also contributes to writing the history of the development sector more broadly. Many aspects of the history of FAO and the development sector pertaining to food remains unknown (Pernet and Ribi Forclaz 2019). Other parts of the UN system and development aid movement has received significantly more scholarly attention (Pernet and Ribi Forclaz 2019). Furthermore, the history that has been written emphasizes the institutional perspectives and contributions of American civil servants. In this thesis, I emphasize the history of FAO's scientific contributions and their impact on the organization itself, the development sector, and the world.

The thesis thus aims to fill a research gap that stands at the intersection of the history and politics of nutrition and agriculture as well as statistics and the development movement. Due to the scarcity of comparable literature, I have searched elsewhere for inspiration on how to do critical research on food security quantification. A central inspiration for the thesis has been the literature on so-called *political agronomy*

(Sumberg and Thompson 2012; Sumberg 2017). With foundations in academic traditions such as science and technology studies (STS) and political ecology, the field has the objective of exposing political-institutional dimensions of how agronomy is constructed as a discipline and practice (Taylor, Bargout, and Bhasme 2021; Sumberg, Thompson, and Woodhouse 2012). Like STS (Jasanoff 2004; Latour 2012), it claims not only that the knowledge produced by agricultural science is used politically, but that norms and values are embedded in the discipline.

This doctoral project investigates the science, history, and politics of food security and nutrition. It therefore goes beyond agronomy, which can broadly be defined as a scientific discipline that seeks to understand and affect the biological, physical, socio-cultural, and economic bases of crop production and land management (Sumberg and Thompson 2012). Agronomy is in other words the core component of agricultural research. The history of the modern food security concept is however connected with, and has in some cases replaced, agriculture and agronomy as a disciplinary framing of science and technology pertaining to agriculture (Andersson and Sumberg 2017), even though the concepts carry different meanings. Since the dissertation draws heavily on the field of political agronomy by utilizing perspectives that study the knowledge politics of science pertaining to food and agriculture, it may be situated in this academic tradition.

The book *Contested Agronomy: Agricultural Research in a Changing World* (2012) was central in launching political agronomy as its own field. It emphasizes the history of and contestation surrounding agronomy. For most of the 20th century, agronomy was however considered a technical discipline that focused on practical matters.

Agricultural research over the last decades has become increasingly contested, as the social, technological and environmental aspects of the agri-food system have changed and interacted in complex, uncertain and non-linear ways, rendering conventional approaches to agronomic research inadequate, opening the field to normative contestation around issues such as rights and justice (Sumberg, Thompson, and Woodhouse 2012). The debates surrounding agricultural research have expanded further into epistemology and value debates over the last years (Andersson and Sumberg 2017).

Contemporary agronomy thus spills over the traditional boundaries of the field. An element of political agronomy that has heavily inspired this dissertation is its particular emphasis on contestation surrounding problem framings, perspectives, methods, and interests in the agronomy field. Charting out domains of contestation and knowledge politics is emphasized as promising empirical arenas. According to Andersson and Sumberg (2017, p. 8) the central question when investigating the nexus of science and knowledge politics, is why different forms and dynamics of contestation arise and how they evolve. The key proposition is that individuals and organizations get involved in contestation in order to influence the direction of debates and outcomes, or to promote or hinder a particular approach, method, interpretation, or technology. Some proposed questions are when and how interests of different actors diverge or converge around particular issues, how epistemic communities or coalitions are formed, and what values and world views underpin these, whose success counts and who and what is counting that success. Another critical issue is the characteristics of the object of contestation itself, which in my case is global statistics on food security and nutrition.

In part through this emphasis on contestation, political agronomy has successfully illustrated the tensions within the discipline's self-representation as a purely evidence-based science that is removed from questions of values, local context and politics (Taylor, Bargout, and Bhasme 2021). Even though the context of statistics on food security and nutrition is somewhat different, this general emphasis on studying spaces of contestation and knowledge politics has been highly influential on the empirical orientation of this dissertation. This influence can for instance be observed in Articles 2 and 3, both of which in different ways emphasize contestation in the process of crafting an SDG indicator framework, including with regards to SDG 2 (*Zero Hunger*). This includes contestation surrounding specific indicators of food security and the institutional setup for the SDG indicator process itself, as well as the mandate and role of the community of statisticians that are tasked with creating the indicator framework.

This impact of political agronomy on the dissertation extends to its emphasis on the history of science and technology pertaining to agriculture. It shows how history is a promising avenue for uncovering contestations in science pertaining to food systems. Sumberg, Thompson, and Woodhouse (2012) broadly divide recent agronomical history into three key trends. Until the mid and late twentieth century, agronomic science in both developing and developed countries took place in state-funded institutions such as universities, ministries, and research institutes, developing as an applied and practically oriented field. Its function during this period has been interpreted as primarily being a tool of state intervention. Agronomy was furthermore heavily involved in the colonial era, spurring a sub-field of *tropical agronomy*, which later transformed into development-oriented agronomy to reflect the transformations from colonial to independent and developmental states (Ross 2014; Sumberg 2017). The emergence and influence of neoliberalism as a political program signaled a sharp break with this state-dominated role of agronomy, referring to a global wave of market liberal reforms of economies and governments from the late 1970s and onwards. The guiding principle was that markets are the most efficient in allocating resources, requiring enforcement of private property rights and free trade, entailing a dominant role for large corporations and the broader private sector.

The last decades of agronomy have also been characterized by the onset of new normative agendas and frameworks. The environmental agenda can trace its roots back to the publication of Rachel Carson's Silent Spring in 1962, which was a landmark for drawing public attention to environmental degradation. Agro-ecology and biodiversity lie at the heart of the environmental debate in agronomy (Sumberg, Thompson, and Woodhouse 2012). The participation agenda has been significant for agronomy. In consisted of two developments: One of them marked a support for the neoliberal agenda in seeking to reduce government power through privatization (Leal 2007). The other was rooted in movements seeking social justice, rights and empowerment inspired by among others Paulo Freire (2013). The participation agenda has been accompanied by a rising hostility to top-down approaches to development as well as interest in the inclusion of farmers and other stakeholders in science and technology development (Sumberg, Thompson, and Woodhouse 2012; Okali, Sumberg, and Farington 1994; Scoones and Thompson 1994).

As described in the research articles, the development of statistics on nutrition and food security can in some ways be situated in this historical narrative. This in particular pertains to the support it has offered to the state-centric and productivist agricultural paradigm from around the middle of the 20th century. The use of quantitative indicators for food security has furthermore become relevant with the emergence of the NPM agenda's emphasis on impact measurement. Both the participation and sustainability turn are increasingly relevant to food security statistics: The authoritative expert group and organization HLPE-CFS works to include the dimensions of sustainability and democratic agency in contemporary definitions of food security as well as in statistics on food security (HLPE-CFS 2022; CFS 2019; HLPE-CFS 2020).

Not much has been done to further develop the conceptual frameworks and empirical program of political agronomy. Taylor, Bargout, and Bhasme (2021) suggests the conceptual integration of insights from political agronomy and political ecology in order to link the emphasis of contested knowledge politics at the institutional level to a firmer understanding of the socio-ecological contexts of agricultural research, practice and governance. Three areas of synthesis are suggested and formulated as questions: 1) who performs agriculture, 2) under what circumstances and 3) with what livelihood implications. It is argued that these questions allow us to consider how agricultural knowledge and technologies take part in producing landscapes in both a social and agro-ecological sense.

This thesis should be interpreted as another argument for the extension of the perspectives of political agronomy. It particularly points towards the potential for a broader empirical outlook of critical investigation. In this sense, it charts out a potential path for a broader field of critical research on science and technology pertaining to food and agriculture, inspired by the tenets of political agronomy. This includes the theoretical framework of the pathways in science and technology for sustainability and development (Leach, Scoones, and Stirling 2007), which is further fleshed out in section 4 of this introduction.

1.3. Research questions

The overall ambition of this dissertation is to shed light on the dynamics of knowledge politics in global statistics on food security and nutrition. This provides a basis for formulating a primary research question:

How does politics shape global statistics on food security and nutrition?

To operationalize the overarching research question, I have broken it down into three secondary research questions. Each question provides the basis for a separate research article included in the dissertation. By guiding the thesis in the direction of more specific topics, the secondary research questions allowed me to provide a response to the primary research question in a more granular and manageable manner, suitable for its article-based format. In the last three sections of the introduction (*kappe*) to the dissertation, I bring together the different perspectives from the three articles and secondary research questions. In this way, I hope to respond to and highlight the complexity and intricacies of my primary research question.

Secondary research questions:

Article 1: *What aspects of hunger and undernutrition have been made legible by the Prevalence of Undernourishment indicator?*

Article 2: *What political dynamics drove the SDG 2.1 indicator selection process?*

Article 3: *How has the SDG indicator process attempted to manage boundaries between science and politics?*

The thesis deals with two intertwined empirical cases. The most prominent global indicators on food and nutrition are produced by international organizations. The historical development of global undernutrition measurement by FAO is therefore one important empirical focal point. The second context is the monitoring of progress in the SDGs through its indicator framework. Through the global development goals of the SDGs, UN member states have pledged to end hunger by 2030, aiming to transform international food systems. The ambitious goal is the second of the 17 Sustainable Development Goals (SDGs) adopted in 2015. SDG 2 boldly aims to "*End hunger, achieve food security and improved nutrition and promote sustainable agriculture*". It consists of eight targets and 14 indicators. The SDGs are therefore a crucial arena of policy, governance and setting of norms for the global food system. I study the model-based indicators FIES and PoU which have been selected to monitor SDG Target 2.1 (FAOSTAT 2022; FAO et al. 2022; WFP 2015). I also emphasize the Inter-agency and Expert Group on SDG indicators (IAEG-SDGs), whose mandate it is to craft an indicator framework for the SDGs and members consist of representatives from national statistical bueaus.

2. Methods and methodology

The coming section will describe the methods used in this doctoral dissertation. The interdisciplinary literature concerned with indicators makes very few explicit methodological reflections (Berman and Hirschman 2018). Some important cues can nevertheless be found. In the first chapter of her book *The Seductions of Quantifications: Measuring Human Rights, Gender Violence and Sex Trafficking* (2016), the anthropologist Sally Engle Merry included some paragraphs on methodology. Studying quantitative methodologies in the context of international indicators is described as a "*study not of a particular place but of a global one: it traces processes that stretch across nations and continents*" (Merry 2016, p. 9). She furthermore described the empirical context as a transitional, de-territorialized space, rich with shared meanings, practices, and technologies.

In terms of methodologies for studying indicators, she particularly suggests writing the *genealogy* and *ethnography* of indicators. These methodological proposals have been important inspirations for this dissertation. They are, however, short and non-exhaustive, with a significant potential for elaboration. I therefore hope to contribute with some reflections on how to flesh out a methodology that is tailored to study numbers and quantification, and particularly for writing *genealogies* of quantitative methodologies.

The triangulation of methods in this doctoral project is also inspired by Merry (2016). She combined the use of ethnography, informal conversations and interviews with extensive documentary records, including both records from meetings and quantification projects. Her ethnographic fieldwork involved attending meetings and workshops, discussions with participants in global indicator projects as well as informal conversations and formal interviews. I initially planned to undertake ethnographic fieldwork in a series of workshops intended for statistical capacity building in collaboration with a hosting UN agency. This fieldwork was scheduled to start around the time that the covid pandemic started in 2020. Due to the pandemic, the empirical emphasis of the project shifted to archival work, documents, and semi-structured interviews. In the context of a global pandemic, interviews were far easier to carry out than ethnography, as they could be performed remotely and in accordance with comprehensive pandemic restrictions. Documents could furthermore be located in online digital repositories and archives. A third source of empirical material comes from the mining of online databanks and old reports for numbers used to construct series of data.

I will now proceed to describe the methodology of *genealogy of numbers* in greater detail. The following sections will also present the document material used in the thesis, before moving on to describe the method of document analysis. At last, I will detail the interview material used in the thesis as well as its analysis.

2.1. Methodology: A genealogy of numbers

Merry (2016, p. 6) describes the genealogical method as asking how an indicator develops, which actors and institutions promote and finance it, as well as how and when its features become settled. It considers how creators grapple with converting broad and complex phenomena into a series of measurable and named concepts. She suggests an empirical emphasis on the micro processes through which surveys are created, categories defined, phenomena named, and translations enacted. These microprocesses are in turn shaped by the actors, institutions, funding, and forms of expertise involved. It is therefore particularly important to track what forms of expertise are involved in creating a quantitative methodology, and which organizations develop and fund it and the related data collection. Tracing the development of indicators, their institutional basis, and what opportunities are present for contestation can reveal exertion of power that is otherwise concealed.

As will become apparent in all three research articles that are part of this thesis, these themes connect my empirical work. Merry (2016), however, provides quite scarce guidance on how to use genealogy as a method and no historical context for the concept of genealogy. Genealogy was developed into a methodology by Foucault (1980), who in turn based his work on Nietzsche's (1887) *On the Genealogy of Morals*. In the essay *Nietzsche, Genealogy, History*, Foucault suggests that genealogies should emphasize the history of what we tend to feel is without history. Concepts, knowledge, values, ideals, and morals are particularly promising contexts for genealogies (Foucault 1980). He describes it as "*grey, meticulous and patiently documentary*" (p. 139), requiring a knowledge of details while depending on working with written historical sources. The method is in particular dedicated to picking apart the "*origin*" and "*coherent identity*" of its object of study, as well as teleological, naturalistic and linear accounts of history (Foucault 1980, p. 147).

I would argue that these traits make genealogy a particularly useful method for humanistic and social studies of numbers. Scientific facts broadly, but numbers especially, are often framed as universal, objective and timeless (Merry 2011; Porter 1995). Indicators for instance tend to become more and more settled and less open to change over time (Merry 2016, p. 8). They often begin with open discussion among alternative measurement strategies, but gradually become more established and certain. As they crystallize and become naturalized, categories and methods may become fixed and difficult to change, with less room for contestation and criticism. Some aspects are settled and not open to debate, while others are continuously refined. Deconstructing the universality and timelessness of numbers through showing the heterogeneity and non-linearity of their history is therefore particularly important and impactful. In the coming paragraphs, I detail some potential sites for unearthing contestation and controversy concerning measurement.

The project has prompted some reflections of what kind of empirical questions are interesting to dive into when performing a genealogy of numbers. The thesis does for instance not just outline the history of concepts as suggested by Foucault (1980), but the history of quantitative operationalizations of such concepts. As discussed in section 1, science often simplifies complex phenomena and beings to make them fit into its own analytical schemes. A methodological reflection that has emerged from working on this thesis is that a history of concepts in quantification can be studied at several distinct, but meaningful levels: The concept that a certain measurement technique *seeks to capture*, can in itself be a reductive version of a more complex concept or phenomena. However, further discussions can explore what concepts a measurement technique *actually does capture* and in which sense this corresponds to the concept it is trying to capture. Statistics on food security and nutrition provides some interesting examples.

The FIES aims to capture the access dimension of food security through measuring the experience of food insecurity. In its current design, this is reductive in the sense that it emphasizes access to food, to the potential exclusion of newer elements of the food security concept such as agency or sustainability. It furthermore uses interviews of individuals or households through surveys. Concepts such as for instance agency and food security can however also be conceptualized at the collective level in the sense of nations and communities, as shown by the food sovereignty movement (Agarwal 2014; McMichael 2014). However, as it is based on a survey of eight questions and only binary (yes or no) responses, the validity of the indicator can easily be questioned. We can thus discuss both the concept of food insecurity that this specific quantitative technology aims to capture, but also in which sense it manages to capture it.

Another promising avenue for research on the genealogy of numbers is their classification schemes and taxonomies. The concepts ingrained in taxonomies of quantification are rarely self-evident (Fjelland 2021). Basic conceptions of hunger have furthermore changed significantly throughout history (Vernon 2007). As shown in Article 1, the statistical definition of undernutrition has also varied drastically with different types of data, thresholds, and definitions.

Researchers can moreover emphasize the equalizing effect of numbers. Quantifying individuals, society or the natural world always entail making objects that are different equal to each other (Desrosières 1998). Looking for what differences we erase through specific indicators is therefore an interesting exercise. Quantification works best when coupled with scientific, political, or administrative transformation (Thévenot 2022). Porter (1994) for instance highlights how measurement and quantification always seem to result in standardization. This standardization can be epistemic, in the sense that measuring a concept can redefine and standardize that concept. A prolific example of this is how IQ standardized the interpretation of intelligence, which is a concept that has accommodated a plethora of different interpretations (Gould 1996). Another example is how the World Bank's dollar-a-day poverty measure has standardized a complex and relational concept of poverty in a narrow and instrumental manner (Jerven 2018). However, quantification can also lead to more tangible standardization efforts. A prolific example of this is the massive and exceedingly difficult standardization project that followed the implementation of uniform weight and length measurements after the French revolution (Scott 1998).

2.2. Document material

The articles include reviews of documents from primarily two sources:

1) The process of crafting an SDG indicator framework.
2) Reports that present historical undernutrition measurements and their technique.

The documents from 1) is important empirical material and background information for Article 2 and 3 of this dissertation, which revolve around the process of crafting the indicator framework for monitoring the SDGs. They include summaries of important meetings, negotiations and consultations, reports, and declarations of relevance to the SDG meetings. The most crucial source of these documents is the inputs, summaries, and outcome documents of the meetings of the IAEG-SDGs. This includes consultative meetings between the IAEG-SDGs with broad sections of civil society present, such as of NGOs, academia, think tanks, private business and international organizations. This group of documents have most often been prepared and uploaded by the United Nations Statistics Division (UNSD), which acts as the secretariat for the indicator process on a mandate from the UN Statistical Commission.

The second main source of documents is the archives of FAO's David Lubin Memorial library. Due to covid restrictions, the library was closed to visitors from the start of the pandemic to the summer of 2022. Finding the right documents thus relied on searching through FAO's digital document repository, and subsequently financing their digitization by using my own PhD funds.

From 1946 through 1996, FAO published measurements of international hunger in its flagship World Food Survey reports. The report series have, with the exception of the already available Sixth World Food Survey (1996), been digitized as a result of this PhD project. It has also digitized and used the reports documenting the historical work of FAO and later the World Health Organization and the United Nations University in order to make quantitative thresholds for under- and malnutrition. The digital versions of these documents can now be accessed through the library webpages.[2] The project has moreover analyzed and reviewed all the annual State of Food Insecurity and

[2] These documents can be accessed online through the FAO document repository and physically through FAO's David Lubin Memorial Library.

Nutrition in the World (SOFI) reports from the first one (published in 1999) to the most recent one (published in 2022), which were already available online. A selection of other relevant reports have also been analyzed and/or digitized through the project, such as technical reports for the FIES and PoU, the historical State of Food and Agriculture series, and reports detailing the contents of FAO's Food Balance Sheets. A list of reviewed documents is included in the supplementary material of this dissertation.

2.2.1. Extracting quantitative data from reports

The thesis reconstructs and analyzes contemporary and historical data series. Such measurements are mostly used to describe the significant instability in measurements caused by methodological changes and access to new data. FAO warns that measurements published in different years should not be compared due to frequent methodological tweaks and adjustment of trend lines (FAO et al., 2020). However, comparing old and new measurements is valuable, as demonstrated in Article 1 where the consistency of the PoU's measurements over time is evaluated.

The project relies on quantitative data for creating a series of figures that are used in Article 1 and 2. In Article 1, the relevant statistics are not available in databases but have been extracted from reports to build data series that facilitate comparison between different estimates across different periods of time. Other data have been extracted from FAO's official data bank, which only includes the latest published figures and trend lines (FAOSTAT 2022). I have also been granted insight into the household survey data basis for the PoU's measurements by FAO. It has been used to analyze the current data basis of measurement for the PoU with descriptive statistics and scatterplot diagrams. This data has to my knowledge not previously been shared with researchers outside of FAO.

2.2.2. Document analysis

Genealogy emphasizes the study of written sources. This thesis therefore uses document analysis. Document analysis is a systematic procedure for reviewing or evaluating printed or electronic documents (Bowen 2009). Documents *document* something for a reason. They are *relational* in the sense that they always relate and point to something outside of themselves (Asdal and Reinertsen 2021).

Documents contain text, pictures and numbers that have been compiled and presented. They can include reports, agendas, meeting minutes, background papers, brochures, journals, letters, programs, newspapers, maps, charts, press releases, summaries, transcripts, various public records, and other formats. They are often found in libraries or different kinds of repositories and archives. As described, most of the analyzed documents have been both located and digitized through archival work. My material consists of historical reports with a technical content, often oriented towards shaping policy as well as summaries of meetings and consultations.

As recommended by Bowen (2009, p. 28), the project employs document analysis as part of a methodological triangulation with interviews. In this thesis, documents have served as a source of both background information and historical insights – in particular for understanding the historical processes of the SDGs indicator framework and the historical development of methodologies to measure food insecurity and nutrition. Subtle changes in reports can reflect significant changes in a methodology or project (Yin 1994). Examining a series of historical technical reports on measuring global undernutrition allows me to trace changes in the technical basis for measurement of global undernutrition. Moreover, document analysis is often less time-consuming than other research methods. Documents can furthermore be easier to get access to. These are all important arguments that have influenced my decision to utilize document analysis, as much of the thesis work has taken place in a context of strict pandemic restrictions.

Documents can be thought of as a specific place, and studying them as an *empirical field* where different actions are created (Asdal and Reinertsen 2021, p. 17). They can also be studied as a *tool*, in terms of having specific functions and effects. One can further emphasize the discursive or rhetorical levels in the *text* itself. A document can also be studied as the *outcome* of a specific process. We can furthermore study how documents contribute to a specific external *cause*, or how it *moves* between different agents, situations, or contexts.

In Article 2 and 3 I emphasize documents as the outcome of the SDG indicator process and in turn as objects that shape this process. An example of this is the impact of documents in establishing the mandate for the indicator body IAEG-SDGs, but also as empirical documentation of the numerous rounds of consultations on the indicator framework with a wide range of actors from civil society, national bureaucracies, and international organizations.

I have also emphasized how documents act as tools for developing methodologies and measurement techniques, while looking at how they have been used to motivate particular causes and policies outside of themselves. This is particularly relevant in Article 1, which deals with documents (reports) as the main avenue for presenting technical changes and novelty in global measurement of undernutrition.

In this dissertation, documents have thus been analyzed as empirical fields and outcomes of important processes from which we can learn about the SDG process. In terms of seeing documents as tools, Article 1 considers documents as a kind of knowledge tool (Asdal and Reinertsen 2021; Riles 2006). They are knowledge tools in the double sense that knowledge is recorded in them, but also made visible. The scientific reports that I analyze in Article 1 are therefore regarded as an optical technology that render new and old knowledge legible in particular ways, in line with the broader theoretical concept of legibility (which is discussed in section 4). In these reports, quantitative technologies are used to render international food insecurity visible. However, their lens is not neutral in terms of ideology, values, or normative implications. These series of documents are not purely scientific documents, as they explicitly evaluate, discuss, and recommend policy. It is therefore interesting to study how quantitative technologies are embedded in the reports and how these in turn relate to policy discourse. A key finding in Article 1 is that the PoU-model in its early days was informed by and in turn fed into a discourse of productivism. This entailed framing global hunger as first and foremost an issue of producing enough food to feed the current and future world population. The reports thus function as synergetic technologies of knowledge and governance.

2.3. My interview material

Aside from documents, interviews are the main source of empirical material for this dissertation. 15 interviews with key informants from the IAEG-SDGs, UN organizations, diplomatic missions, and national bureaucracies are used in Article 2 and 3. The informants were chosen to investigate the work of the IAEG-SDGs from different perspectives on the SDG indicator process. Interviewing the statisticians that have the mandate to shape the indicator framework has been essential for the thesis. So is interviewing individuals in UN agencies and national bureaucracies that played a role in the process. This variety of relevant backgrounds represented through the interviews is intended to ensure that my empirical material captures a plurality of perspectives and accounts of the indicator process. It has, however, not been possible to to interview all members of the IAEG-SDGs. A potential explanation for this is the sensitivity of its work due to its high-profile international mandate in a contested field of global sustainable development.

13 interviews were audio-recorded while two interviews were documented by written notes. All interviews were conducted with the consent of the informants and all used quotes have been approved by interviewees. The individuals interviewed are anonymized, as most have an active role in the SDG indicator process and are interviewed about what should be considered a sensitive subject matter. The interview guide was created using background knowledge of the SDG-process and informal conversations with individuals with knowledge of the SDG indicator process.

Informants were asked broad questions about the process of crafting an indicator framework for the SDGs. This includes the role of their specific expertise in shaping the framework. The interviews also dwelled on questions pertaining to the place of science and politics in the SDGs. A particular emphasis was put on the role of the IAEG-SDGs as a technical body, and on self-interpretation by its members. Beyond reflecting on their own positions as dual technical experts and decisionmakers playing both national and international roles, the informants reflected on the role of other actors in the process, such as policy officials, diplomats, national governments, and international organizations, as well as the consequences of their influence. As I will discuss later in this section, the interviews provided narratives that highlighted important aspects of the SDG indicator process. They also provided narratives centred on the role and self-interpretation of the statisticians tasked with crafting the indicator framework.

2.3.1. The potential and pitfalls of using interviews

Conversation as a means of acquiring systematic knowledge is a well-established academic tradition. Socrates for instance developed knowledge through conversation with his opponents. The term interview, however, came into use in the 17th century and was used in systematic forms to a varying extent by the social sciences in the 20th century. Kvale and Brinkmann (2009, p. 20-22) define interviews as a 1) craft resting on the practical skills and personal judgements of the interviewer, 2) as a social production of knowledge where interviewer and interviewee through their conversational relationship produce knowledge and 3) as a social practice laden with ethical issues, power asymmetries and social influences.

This section discusses the strength and pitfalls of using interview data. By doing so it also enters into some important theoretical debates that concern what inferences we can draw from interview data. This allows me to clarify why I have chosen to use interviews as source of empirical material, and it further allows me to provide crucial justification for the choices made in analyzing the interviews. While such debates use a methodical language, what is discussed is often theoretical issues. This particularly concerns individual versus collective constitution of meaning.

Meanings are important for understanding the self and the social world (Tavory 2020). DiMaggio (2014) claims that meanings are collectively bargained in social and physical spaces that can constrain the expression of individual opinions. However, different actors at the individual level often enter such negotiations with significant and stable cultural dispositions. According to this view, culture constitutes a so-called "*ecology of representations*" with social contexts selectively reinforcing or suppressing items in individually variable cultural repertoires (DiMaggio 2014, p. 232; 1997). Therefore, individual interviews are often appropriate units of observation when it comes to the study of culture, although collectives may be the proper unit of analysis.

Human meaning does not exist simply to be discovered by researchers. Such a view of meaning might lead to a reification of the subjective, rather than taking into account that meanings are also reconstructed through conversational interactions. According to Jerolmack and Khan (2014), methodological instruments such as interviews and surveys that rely on individual-level accounts of behavior, risk removing a crucial social component of data by understanding meanings as made by or within the individual. A more constructive conception of interviews therefore moves the emphasis from an individual conception of meaning to be discovered, to an inter-relational constitution of meaning (Kvale and Brinkmann 2009). That different interviewers can construct different meanings from the same interview then becomes not a problem, but a fruitful virtue of interview research.

Lamont and Swidler (2014) further note how interviews allow for and encourage systematic attention to research design and in particular comparison across contexts. Interviews can make someone construct the meanings of interactions, social contexts, and institutional situations in a manner that ethnography is most often not able to do. As a result interviews can sometimes reveal more features of reality than participatory observation because they enable researchers to ask about facts, responses or imaginary scenarios that are not visible during everyday interactions, but that are nevertheless highly relevant for our understanding of the social world.

Lamont and Swidler (2014, p. 157) also argue that we should have an open-ended approach to interviews where we do not solely collect data about behavior, but also about "*representations, classification systems, boundary work, identity, imagined realities and cultural ideals, as well as emotional states*." I emphasize the narratives and meanings that interviews enable us to construct, in addition to practical details of historical processes. The narratives of understanding the self and the social world that we partake in are viewed through a metaphor of *landscapes of meaning*. This will be elaborated upon in the next section.

2.3.2. Analyzing interviews: Exploring landscapes of meaning

This section outlines the thesis' analytical approach to interview data. The article *Interviews and Inference: Making Sense of Interview Data in Qualitative Research* by Tavory (2020) is meant to be used as a tool for coding and analyzing interview transcripts. It has been an important resource for the analysis in this dissertation. The article provides both a practical hands-on approach to how we should to draw inference from interviews, while discussing theoretical debates on how to perceive interviews in relation to situated action and meaning.

Tavory (2020) claims that different parts of a transcript may require different kinds of inference: An essential component of the skill of analyzing interviews is to know which parts of an interview calls for what kind of analysis. In most interviews and particularly semi-structured and semi-open interviews there are roughly three different contexts in terms of inference: In open contexts, one can infer about situations that are external to the interview. In rare hermetically closed contexts, interpretation stay in the bounds of the interview situation. In refracted contexts, the relationship between the interview and other situations is more unclear.

In open contexts, researchers can make the argument that the interview data represents an informing image of people's lives beyond the interview situation. According to Tavory (2020), the most important open context is what is interchangeably referred to as *ethnographic interviews* or *process-oriented interviews* (Spradley 1979). Such interviews emphasize how, what, when, and where, rather than why. By focusing on factual and processual questions the interviewer gives the respondent a *mnemic hook* that they can use to construct their narratives (Tavory 2020, p. 4). With regards to biographical narratives and organizational history this is often the only way to get data. Open contexts usually point towards social processes rather than attitudes and to the past and present rather than the future. My interviews have to an extent been *process oriented*, in the sense that they have asked interviewees to detail events in the SDG indicator process. This provides crucial empirical material for Article 2 and 3. Purely open context interviews however do not exist. One cannot ask how something has happened without partly getting a response to why it happened.

There are certain questions and interview types that need to be considered as closed contexts. Analysis of closed contexts can, however, be interesting. One mode of analysis that utilize interviews explicitly as closed contexts is ethnomethodological inquiry. Such research analyzes how particular ways of asking questions induce certain answers and silences, how interviewees co-create the interview and how interactions are made. A different kind of closed context pertains to hypothetical questions that one can assume the interviewees have never before thought about.

We should not, however, think of interview data as singularly open or closed in a context of inference. Interviews allow the researcher to study the important human attribute of communicating narratives about who we are and what we do. According to Tavory (2020, p. 8), we should assume that such representations and narrative constructions are refracted representations of how interviewees represent their world in other contexts. Aspects of the interview may be relevant to other contexts, but we should not assume that they perfectly represent what people think. They are however intertwined with other contexts (Holstein and Gubrium 1995). According to Lamont and Swidler (2014, p. 157), interviews primarily give a sense of people's "*representations, classification systems, boundary work, identity, imagined realities and cultural ideal*". Becker (1996) argues that it is hubris to assume that people talk to researchers in a radically different manner than they do to others. The interview situation may, however, produce narratives that are different from the ones that would be constructed in other situations.

Tavory (2020) uses Isaac Reed (2011) metaphor of culture as a *landscape of meaning*. In-depth interviews provide a sort of window into cultural sense-making. As such they can help us construct the general contours of the landscape where the action takes place. Such contours do not constrain only what elements we fit into the landscape, but also how we construct the landscape and how connections between the different elements are organized. This provides a useful way to think about the different possible relationships between the representations that interviews draw forth and narratives that exist outside the interview setting. Interviews give a sense of what kind of narratives make sense in the world of the interviewees and elicits representations and narratives that may identify structural aspects in the landscapes of meaning. Interviewers, however, need to know enough about the interviewees to get an idea of whether the talk of interviews resemble talk in other situations, and whether or not they talk and think about these questions in other settings.

Through using interviews as a method, I attempt to chart out such landscapes of meaning among practitioners of statistics in an international context. I specifically analyze the parts of my material that revolve around the meanings that a specific community of statisticians formulate when making sense of their own role in a complicated and contested international process. Their group consists of statisticians from national statistical offices (NSOs) that are mandated to craft an indicator framework for the SDGs (IAEG-SDGs). The practical process of performing this analysis via theme identification is described in the coming section.

2.3.3. Identifying and analyzing themes

In the coming paragraphs, I round off the methods section by describing the practical method used to draw inferences from my interview data. The NVIVO software was used to identify, organize, and code relevant themes for the purpose of data analysis. Ryan and Bernard's (2003) article *Techniques to identify themes*, focuses on discovering themes and subthemes in texts and other qualitative data. To Ryan and Bernard (2003, p. 87), the terms *theme* and *expression* connote the fundamental concepts in qualitative analysis. Without thematic categories, there is nothing to describe, compare and explain. Themes are defined as conceptual linkages of expressions. There are many ways in which expressions can be linked to abstract constructs. Being explicit about how we identify themes allow readers to assess crucial methodological choices, providing some transparency about the analysis.

Themes can come from data (induction), but also emerge from a priori theoretical perspectives or presuppositions. Bogden and Biklen (1998) proposes analyzing the setting and context, the perspectives of the informants and their ways of thinking about people, objects, processes, activities, and relationships. Others argue that researchers should be sensitive to the conditions, interactions and consequences of a phenomenon and to use these components to form new theories and concepts inductively (Strauss and Corbin 1990).

Theme identification does not entail a single correct solution. There is not a final set of categories waiting to be discovered (Dey 1993, p. 110-111), and there are endless ways of perceiving the data. There is furthermore no ultimate way to demonstrate the validity of the identified themes. What one can do is maximize clarity, transparency and agreement (Ryan and Bernard 2003). For instance, theme identification involves judgements by the researcher that should be made explicit and clear, enabling readers to comment on the researchers' analysis.

Ryan and Bernard (2003) detail a range of scrutiny techniques - methods to identify themes. The most relevant for my analysis of interview data is *repetition* and *indigenous categories*. Repetition is one of the easiest ways to do such identification. The more the same concept occurs in a text, the more likely it is a meaningful theme. How many repetitions of a concept are enough to constitute such a theme is an open question. Only the researcher can decide where this threshold should be. An alternative way to locate themes is to look for unfamiliar local themes commonly referred to as indigenous categories or typologies. Patton (1990) contrasted these to *analyst-constructed typologies*. Some techniques require specific expertise, and this is especially true for indigenous typologies.

What technique is appropriate for discovering themes depend on the type of data (Ryan and Bernard 2003). When texts are shorter and less complex, it becomes less fruitful to look for transitions, metaphors, and linguistic connectors. My interviews with statisticians are rich in the sense that they bring forth interesting narratives that reflect the making of meaning for a group of statisticians in the technocratic language of their profession, but not by virtue of variation and complexity in metaphors.

Some themes were chosen for further analysis because they can be interpreted as *indigenous* (Ryan & Bernard, 2003). They arise from specific scientific discourses that require exposure to certain kinds of academic traditions and disciplines to partake in. As a trained economist with a methodological background that consists solely of quantitative methods, I understand quite a lot of statistical discourse. Translating such discourses is particularly valuable in shedding light on the self-interpretation and narratives of crucial actors in the SDG process as well as academic and bureaucratic communities that produce and utilize statistics.

From the analysis, four interrelated themes emerged through repetition. One theme was the professional and scientific culture underlining the IAEG-SDGs as a community of expertise. A general finding from the interview material was that the statisticians held particular interpretations of their own role as arbiters and guarantors of scientific objectivity in crafting the indicator framework. As outlined in Article 3, the narrative of separation between the technical and the political process built into the SDGs is reproduced by the experts involved. This view in turn entailed a binary conceptualization of technical and political aspects of the SDG indicator process, accompanied by related distinctions between what was or was not legitimate actors and topics of contention in the process of crafting a global indicator framework. The community of statisticians was contrasted with what is considered decidedly political actors and elements, such as diplomats and policy experts, and rendered a group with strong commonalities in terms of scientific culture and validity criteria.

The second theme was the role of national perspectives in different forms, such as the expression of national interests and sensibilities in the indicator process, as well as the national relevance of the indicator framework. A third theme was the role played by different kinds of expertise in the indicator process. These themes were particularly central for the analysis in Article 3, and the use of these themes led to the application of analytical concepts from the studies of expertise in international relations as well as science and technology studies (STS).

A fourth theme was the resource and data constraints that the IAEG-SDGs is subjected to, which is central to the analysis in Article 2. This constraint became particularly apparent with regards to time and expertise. The body only consists of statisticians from NSOs, which makes it highly dependent on expertise from a range of other actors when crafting indicators that are traditionally not part of NSOs portfolios. UN agencies were particularly influential in terms of providing missing expertise and even drafted the initial proposal for indicator frameworks. The repeated narratives of dependency on the initial proposals and certain actors in the indicator process eventually led to use of the analytical concept of pathway dependency (Stirling 2010). This concept will also be elaborated upon in section 4.

2.4. Research ethics

As described, the empirical material of this dissertation consists mainly of documents and interviews. No ethical clearance was needed to attain or analyze the documents, which consist of publicly available reports and summaries or agendas from meetings. These reports have been attained either online or from physical archives. The interviews are anonymized in terms of professional position, ethnicity, nationality, names, gender, and appearance, but the taping of the conversations still qualifies as personal information. Clearance in terms of research ethics was therefore needed. This clearance was provided after the processing of two applications by Norwegian Centre for Research Data (NSD). Further questions can therefore be directed to NSD or to the author of this dissertation.

3. Main findings

In this section, I condense the findings presented in this dissertation. These are formulated in response to the *secondary research questions* that posed in section 1.3, summarizing their corresponding research articles. Section 4 provides theoretical reflections. I outline a focused response to the *main research questio*n in section 5.

Article 1 investigates how the model-based indicator PoU has made world hunger legible throughout its long history. Reported annually by the Rome-based UN agencies in their flagship report *The State of Food Insecurity in the World*, it is generally considered an authoritative statistic on world hunger. Based on archival research, Article 1 chronicles and analyzes the development of its statistical model since 1946 as well as the political and historical context of its revisions.

It shows that technical revisions that have led to substantial changes in the estimates of the indicator have underpinned shifting policy narratives about trends in the fight against hunger. A key example is the revisions undertaken as the Millennium Development Goals (MDGs) were coming to an end and it was time to judge progress. Trend lines showing crises and a decades-long rise in undernutrition were entirely discarded by technical adjustments that bolstered a narrative of global progress in the era of the MDGs. Access to new survey data from China in 2020 enabled FAO to provide verification of the Chinese government's narratives of social progress under authoritarian rule. Times of crisis have furthermore necessitated ad hoc technical revisions to show that more people go hungry during periods of drastic food price inflation, global pandemics, or economic recessions. Its creator FAO's choice of how to *see* the world is tightly connected to and has been an efficient tool to serve its specific needs as an evolving organization.

Due to the PoU's laser focus on measuring caloric undernutrition, it is also worth considering exactly what aspects of food security fall outside FAO's field of vision. Two examples are the elements of democratic agency and sustainability, which are rapidly gaining importance in food policy and science (HLPE-CFS 2020, 2021). By serving as a legitimating tool for promoting productivism, the map provided by the PoU has shaped the terrain and contributed to make it more visible through promoting types of agricultural modernization that tends to lead to production in bigger units. These are in turn more easily measured by caloric accounting. As such, the PoU is also an indicator of the changes in the agri-food development agenda over the last 60 years, from the public sector based Green Revolution of the 60s and 70s to the rise of the neoliberal agenda in the 80s and the last decades' private sector focused New Green Revolution (Sumberg and Thompson 2012; McMichael 2009; Friedman and McMichael 1989).

The UN moreover lacks access to critical national household survey data from the countries with the highest measured undernutrition. At a technical level, this study highlights the need for greater transparency and facilitation of reproduction of results in the data and modelling basis for the PoU. There is fortunately substantial and easily attainable potential for improving transparency by disclosing to the public underlying data, further modelling details and previous time series.

Article 2 investigates the political dynamics of the process of selecting indicators for SDG Target 2.1.[3] Two food security indicators were selected to monitor this target. The first is the previously described PoU indicator. The second indicator is the household level experienced-based food security indicator Food Insecurity Experience Scale (FIES), developed by the FAO in 2013. FAO serves as both SDG indicators' custodian agency, with the responsibility to design their data collection and reporting system.

The political and technical aspects in the indicator selection process were intertwined from the start. While there was significant contestation around which indicators should be selected, the process was characterized by pathway lock-in: The complexity of food security quantification favored already established data infrastructures and milieus of expertise, locking in the position of FAO and its established food security indicators. Key enforcers of this path dependency were resource constraints and limited availability data, as the chosen FAO indicators were among few options with well-established global data infrastructures. The SDG 2.1 indicators frame food insecurity in terms of caloric supply and demand and individual experience, arguably excluding dimensions of democratic agency, sustainability and other dimensions and drivers of food insecurity. The lock-in has thus embedded a narrow concept of food security in the major global indicator framework for food security monitoring. This is likely to

[3] SDG Target 2.1: "*By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.*"

have significant effects on how food insecurity is addressed nationally and internationally.

Addressing the knowledge politics of food security indicators is important to broaden and open up the agenda for sustainable transformations of food systems. Statistics and indicators are important tools in this agenda, but a diversity of approaches and data infrastructures from the local to the international level are needed to understand the multiple dimensions and drivers of food insecurity. Avoiding data inertia through more pluralistic measurement of global food security therefore requires alternative infrastructures that enable data gathering, treatment and standardization on an international scale. Further investments in such infrastructures are needed to adequately capture the multidimensionality of food security through statistics.

Article 3 investigates how the SDGs manage the inherently political aspects of crafting its indicator framework, and what this means for the practice of indicator making. The SDG process purports to cleanly separate politics and technical matters, embodied by the *political* negotiation of goals and targets, and the *technical* creation of an indicator framework. This article finds that the statisticians tasked with selecting indicators through the IAEG-SDGs reproduce such narratives. Manifesting the supposedly scientific side of this binary partition enables the groups to claim the role as neutral experts and arbiters of objectivity, while defending a technical space from influences that are considered politicizing.

The statisticians' participation in the epistemic network of national statistical offices enables a particular kind of management of boundaries between science and politics.

They are seconded to a global process as national experts. The position of disinterested technical expert is therefore never stable but requires continuous boundary work to stabilize the task of crafting an indicator framework. The boundary between science and politics is drawn at the kind of politics that the statisticians invariably must deal with: Inside falls certain unavoidable normative and political aspects of making an indicator framework to monitor politically negotiated targets as well as national sensibilities about what kind of indicators are relevant for different countries. Outside falls the entry of more overt forms of national interests, rejection of certain types of indicators out of national sensibilities, as well as more traditional forms of diplomacy and policy expertise.

With regards to normative implications, the indicator process shows the need to move beyond clean distinctions between dichotomous technical and political spaces when formulating development goals and their monitoring systems. A side effect of the attempt to clinically divide the SDGs into parallel political and technical processes is that contestation about indicators that are highly political in nature is disregarded because it is considered inappropriate in a technical body. I therefore argue that development processes would benefit from more diverse indicator bodies than the IAEG-SDGs. In addition to relevant expertise from international organizations, new indicator bodies should draw upon the breadth of experience and expertise of a broadly defined civil society, including NGOs and academia. Such diversification could explicate already existing political and value contestations, rendering them more transparent and visible to the public. It may also contribute to capturing more of the complexities of sustainable development in future monitoring frameworks through consideration of a broader selection of indicators and methodologies.

4. Theoretical reflections

This section contains the most extensive theoretical reflections of the dissertation. It is structured after the different theoretical approaches used in each article. The analytical framework of Article 1 builds on the theoretical elaborations made by James C. Scott (1998) in the book *Seeing like a State*, making particular use of the legibility concept to analyze the empirical context of statistics. Article 2 emphasizes path (or *pathways*) dependence theory concerning science and technology. Article 3 combines a theoretical concept that originates from international relations (*epistemic communities*) with a concept from science and technology studies (*boundary organizations*).

A lack of theory tailored for studying numbers through the lens of the humanities, social science and law has been claimed (Berman and Hirschman 2018). This thesis however employs and adapts a series of analytical concepts to the empirical context of statistics. The project started off using an analytical framework for studying science that originates from economics, but then moved on to explore other analytical approaches that build on a heterogeneous group of academic traditions. This varied use of analytical concepts from different theoretical traditions is well suited to illuminate different political and conceptual aspects of the measurement of hunger. It also reflects my development in terms of being exposed to an increasing number of intellectual frameworks for understanding science and its interaction with society. However, the different frameworks are all tailored to investigate nexuses of power and knowledge.

4.1. Rendering the world legible through statistics

In *Seeing Like a State* (1998), James Scott develops the analytical concept of legibility. As elaborated upon in Article 1 (*The history of hunger: Counting calories to make global food security legible*), he shows that a central task for the modern state has been to make society more *legible* so that it can be read, distinguished, and seen by the state. Scott argues that the Enlightenment inspired an administrative and scientific ordering of nature and society that enhanced modern states' capacity for observation and control. Expanded legibility in turn supported state functions such as taxation and conscription while enabling modern large-scale social engineering. This legibility was created by efforts like the creation of permanent last names, land registries, standardization of law, language, weights and measures, cadastral surveys, tenure reform and city planning (Scott 1998, p.2).

Article 1 makes the case that legibility is a promising analytical concept for social and humanistic studies of quantification. It follows up by engaging with the concept in a historical study of global measurements of food security through the model-based indicator Prevalence of Undernourishment. The main arguments for applying the concept to the study of statistics is that it makes a direct allusion to the capacity of states and civil society to observe the assets and subjects of society, and further that it places an emphasis on the enmeshment of science and society, and what falls in and out of sight when studying the world through scientific and administrative schemes.

The concept of legibility share strong commonalities with the panoptic principle developed and applied by Foucault (2007) in Discipline and Punish (Carson 2011).

Foucault's concept however aims to describe a technology or mechanism that coerces through observation. Unlike technologies suited for comparison with the Panopticon prison, the PoU is not a tool fit for imposing discipline, punishment, or coercion in any direct sense. The model offers measurement at national, regional, and global levels, and is incapable of further geographical or population-level disaggregation. Its ties to actual people and sub-sections of the population such as marginal or vulnerable groups are thus severed. The strict definition and measurement method of undernutrition that is embedded in the PoU is furthermore not a clinical one, but a weighted average purely intended for the study of abstract and statistical populations (FAO 1950; FAO and WHO 1971; FAO, WHO, and UNU 1985). Its potential for informing and designing direct intervention into people's lives is thus quite limited.

The PoU has however played a role as a key legitimator of a food regime built on a productivism that characterized much of the 20th century (McMichael 2009). It has in particular legitimized the modernization of agriculture through the calling for greater food production and higher yields, for instance through its use and coupling to policy recommendations present in the authoritative report series on international agriculture and nutrition *World Food Survey* (FAO 1946, 1952, 1963, 1977, 1987). It has thus supported modernization schemes in agriculture that facilitate greater state control by driving agriculture into forms that are more easily controlled, registered, and accounted for. This process of modernization and commercialization has in turn rendered food systems much more legible and brought them under heightened state control.

The legibility concept is embedded in a larger theoretical framework tailored to analyze certain pitfalls of modernism. The wish to increase legibility is a common facet of *high* *modernist* ideology. This concept aims to highlight the top-down approaches, cartesianism and ambitious social engineering embedded in certain modernistic projects and perspectives. High modernism is in *Seeing Like a State* described as a strong confidence about scientific and technical progress, the expansion of production, mastery of nature and first and foremost a rational design of social order commensurate with a scientific understanding of natural laws (Scott 1998, p. 4). It thus borrows the legitimacy of science and technology to justify an uncritical attitude to the possibilities for comprehensive planning of human settlement, production, and social life. Scott (1998, p. 378) describes what is new in high modernism as "*not so much the aspiration for comprehensive planning. Many imperial and absolutist states have had similar aspirations. What is new is the administrative technology and social knowledge that make it plausible to imagine organizing an entire society in ways that only the barracks or monasteries had organized before.*" The novel component of high modernism, then, is not the ambition to engage in comprehensive and centralized planning, but the capacity to put such plans into effect.

As an extension of his analysis of the pitfalls of the high modernism, James Scott also mounts a defense and argument for the restoration of prestige for practical and tacit knowledge. He utilizes the Greek concept of *metis* for knowledge embedded in local experience, as contrasted to the abstract knowledge employed by states, bureaucracies, and science. Scott translates the concept as the wide range of practical skills and intelligence needed to respond to a constantly changing natural and human environment (Scott 1998, p. 313). High modernism according to Scott have replaced a collaboration between these two forms of knowledge (practical and abstract) with a scientistic perspective which dismisses practical knowledge as insignificant and dangerous. This interaction between practical and abstract knowledge is framed as part of a political struggle for institutional hegemony (Scott 1998, p. 311).

Article 1 also takes inspiration from some of Scott's broader perspectives. High modernism is certainly a relevant analytical frame for the standardization schemes and rational order of modern agriculture. Scott (1998) even dedicates chapter 8 to modern agriculture as a case of social and scientific engineering that has frequently disregarded *metis*. As such, the concept is relevant to this dissertation, even though it is not directly applied in Article 1. It was left out primarily due to a wish to emphasize the virtues of the legibility-concept to analyze the specific case of statistical modelling of undernourishment.

The article also takes particular cues from Scott's argument that fitting complex beings and systems into scientific and administrative grids requires reduction and idealization. The first chapter of the book details the development of modern forestry and is particularly relevant in this respect. In 17th century Prussia, forestry emerged as a science aimed primarily at maximizing and stabilizing government revenue from logging. The science of forestry replaced old-growth forests that covered Europe with plantation forests built on monoculture with trees arranged in fixed rows, mirroring other types of grids employed by states for the purpose of control and surveillance. Plantation forests eradicated the complexity and heterogeneity of life forms in old-growth forest, replacing it with a structure that reflected the grids and ideal environments for scientific forestry. The numerous uses and purposes of old forests for human communities as well as its place and function in a larger ecosystem thus had to be bracketed out. This bracketing left only one indicator to maximize and stabilize over time: Government revenue. Such bracketing is highly relevant also in the case of food and nutrition. The bracketing of the PoU keeps caloric accounting in focus, while dimensions of malnutrition, sustainability, and agency fall outside of it. These elements have all gained prominence in food security and nutrition discourse over the last decades (HLPE-CFS 2020, 2021; Nelson, Nisbett, and Gillespie 2021; Gillespie et al. 2013; HLPE-CFS 2022).

In this way, modern forestry rendered forests legible for state officials, loggers, and foresters, and shaped the terrain to fit the map. In turn, the terrain became far more legible for the state. The plantation forests shaped by an embryonic forestry science first yielded substantially increased and stable harvests, before steadily decreasing. Such forests were far less resilient to disease and environmental disturbances than old-growth forests. The science of forestry therefore had to emulate some of the natural processes that were lost in the tradition from old growth to plantation.

This instructive example of the interaction between science and the world serves as an important lesson for statistics. The exclusive focus on one outcome parameter (yearly state revenue) led forestry to disregard and destroy the endless uses and functions of old-growth forests. It is easy to draw parallels to the effects of quantification on knowledge and governance highlighted by Merry (2016). When governing by quantification, there is always a danger that an indicator meant to incentivize a certain policy goal in practice narrows or replaces it (Porter 1995).

The interaction between map (science) and terrain (the world) is a useful metaphor for statistics' ability to shape the world through the simultaneous representation and construction that characterizes it. The previously detailed policy reports from the 20th century promote the parts of the food system that are amenable to state control and accounting. This modernization has in turn rendered food systems easier to observe, account for and control. Different aspects and parts of the food system can be placed in a hierarchy of legibility with regards to the caloric accounting techniques that the model depends on. Modern, industrial, and commercial agriculture is the most legible, followed by subsistence agriculture, kitchen gardens, and then different forms of hunting and gathering. Some parts of the food system are thus easier to quantify and integrate in official statistics than others. The PoU was an important legitimizing tool for the ambitions of FAO and the nascent development movement to modernize of agriculture. The map has thus made the terrain easier to read: The application of the lens of the PoU has contributed to make food systems more legible.

The PoU and its forerunners furthermore not only represented the first attempts to estimate hunger internationally but were pioneering global indicators. Before finding a solution to a problem, it is necessary to conceptualize the problem itself. Hunger had to be conceptualized as a global problem with global solutions for measurement techniques with global scope to emerge. As described in Article 1, global hunger estimates emerged in the first World Food Survey (1946), with the methodology of the PoU established later by Sukhatme (1961). Corresponding measurements for other development issues were developed comparatively late. Systematic national gross domestic product (GDP) per capita estimates were published from the 1960s, and the first compendium containing estimates for all countries was published in 1966 (Jerven 2012). Other development metrics such as the World Bank's dollar-a-day poverty indictor and the Doing Business score were published in 1990 and 2003 respectively (Jerven 2018).

The PoU was thus important for opening up a frontier of *global legibility* not just for hunger, but for statistics more generally. The emergence of this particular mode of legibility has not just been important for states, but crucial for international organizations and civil society. It highlights how probabilistic modeling enabled new kinds of legibility, beyond the administrative counting, maps, registries, city planning and scientific practices described by Scott (1998). Global legibility for instance remains highly dependent on probabilistic sampling, as surveying an entire global population is unrealistic. The greater the complexity of the systems represented through numbers, the greater reduction of complexity is required to facilitate quantification. The knowledge and governance effects of measurement (Merry 2019), are therefore made extra potent through the immense complexity of global issues. This is also the case for global measurement of food security and nutrition.

Hence, the concept of legibility is a productive analytical conept for studying different modes of quantification. It alludes more directly than any other analytical concept to a state or organization's capacity for rendering people and assets visible to itself. It furthermore does not necessarily allude to an element of direct control of human beings, making it suitable for analysis of highly abstract modes of quantification such as the PoU. It also incorporates the insight that science and administrative knowledge forms tend to idealize, simplify and reduce complex systems. At last, it pushes attention to the interaction and coproduction of science and society. The legibility concept does however not necessarily point to the coercion, discipline or control that can be embedded in other technologies of modern statehood and governance.

4.2. The pathways of science

In section 1, I outlined political agronomy as a key inspiration for the empirical orientation and perspectives of the thesis. (Sumberg 2017; Sumberg and Thompson 2012). This literature has often applied the pathways approach (Stirling 2010; Leach, Scoones, and Stirling 2007), which is built off a particular conceptualization of processes of path dependence and lock-in. Path dependence theory was initially conceptualized in economics by David (1985), who utilized the famous example of the increasing adoption of the QWERTY typewriters. It has since found broad application in a wide range of different academic disciplines.

Article 2 of my dissertation (*Measuring the End of Hunger*) uses the pathways approach as a conceptual framework. It was originally developed at the STEPS Centre at the University of Sussex, and uses path dependency theory as a framework for linking that links science and technology to environmental sustainability, poverty reduction and social justice (Leach, Scoones, and Stirling 2007; Stirling 2010). It thus combines the study of science and technology with a normative framework that emphasizes the promotion of sustainability and various forms of social justice. It furthermore draws upon complexity theory (Meadows 1999; Mitchell 2009), in arguing that social, technological, and ecological processes are both dynamic in themselves and interact in complex and varied ways. Simple blueprints and highly standardized and inflexible transfers of technology are unlikely to take this complexity into account. Proponents of the framework argue that dynamic systems have often been ignored in conventional approaches for development and sustainability, with standard approaches rooted in assumptions that models of science, technology and policy working in one setting can be transplanted to others. The goals and notions of progress in relation to environment, technology or development are furthermore often contested, with goals and properties open to multiple framings. Depending on the issue in question, several scales may be relevant.

The pathways approach is also inspired by the field of political economy in the sense that it aims to "*put institutions and politics centre-stage*" (Leach, Scoones, and Stirling 2007, p. 8). The dominance of particular pathways and the exclusion of others reflect politics and power. Relationships of power and knowledge are therefore central to the approach. The emphasis on power points attention to how contestation between alternative pathways and goals play out, including contestation over understandings of the past, present changes, or between different future imaginaries of socio-technical change (Jasanoff and Kim 2009, 2015).

Moreover, the pathways concept sacrifices the specificity of certain forms of theorization, such as formalized models, to attend to a wide array of social and material forces that constrains or enables science and innovation (Rosenbloom 2017). It is furthermore predisposed to emphasize particular temporal scopes. In Article 2, I apply the pathways concept to analyze processes of creating an indicator framework related to the SDGs and the relevant food security indicators.

A substantial conceptual development of the pathways framework, that diverts considerably from its original conception, is the addition of the 3D structure of *direction*, *distribution* and *diversity* (Stirling 2010). The notion of *pathway* conveys a *directionality* and the way in which a certain system changes over time, as well as the relevance of historical precedents, current trajectories, and future scenarios. It entails asking the question "*What is innovation for*?", to draw attention to the directions of change that are supported in any given context, shedding light on alternative directions for innovation pathways. Choosing or locking into some pathways over others inevitably involves political choices and trade-offs. Often the alternatives can be obscured by political interests and exercised power, with pathways that meet the needs of marginalized groups or places excluded. Direction is considered important because it shapes the distribution of benefits, costs, and risks, going beyond questions of implementation of technology. For instance, in Article 2 I argue that the institutionally advantaged position and global data infrastructures of UN agencies have contributed to lock in certain indicators.

Another of the 3D's directs attention to the *distribution* of benefits of certain pathways in science and technology, addressing questions of social difference, equity and justice. Stirling (2010) emphasize participatory approaches to science, technology, and development, actively aligning science with the interests of marginalized communities, through for instance context-sensitive adaptations and shaping of technologies. In this way, citizen initiatives, or the *extended peer communities* of Post-Normal Science (PNS) (Funtowicz and Ravetz 1993b), can play a role in opening up hidden innovation pathways.

Attention to the *diversity* of pathways for science and technology can halter the processes of lock-in and path dependence. Diversity can enable sensitivity to varied cultural, economic, and ecological contexts. Creative experimentation in different niches can allow novel paths of innovation to emerge. It is described as paying attention to the social and organizational aspects of science and technology, pointing towards the different interests, perspectives and priorities present in science and technology.

For food systems, the food sovereignty movement and participatory governance mechanisms has brought about alternative framings that emphasize agency in relation to questions of food (Agarwal 2014; McMichael 2014; Rocha and Lessa 2009). A fourth dimension, *democracy,* was added by Leach et al. (2020), following earlier suggestions of a more explicit integration of elements of democratic agency (Millstone, Thompson, and Brooks 2009). It aims to capture whose voices, perspectives and interests that are represented in formal and informal processes of governance of science and technology. This element of a modified 4D framework, emphasizes that science and technology is not shaped in the interests of the poor, because the poor are not present in forums which shape them - such as government institutions, parliaments, or research funding bodies.

An attractive feature of the pathways framework for those studying science and technology in a development-related context (such as the SDGs), is the effort to explicate some of its own normative dimensions. Whether we acknowledge it or not, academic studies of development are fraught with normative, value-based, and ethical contestation (Kvangraven 2021; Sumner 2022). Explicating one's own normative project is therefore beneficial. The pathways framework states its own ambitions in terms of making science and technology work *for* the benefit and emancipation of the poor and marginalized, in addition to promoting sustainability (Leach, Scoones, and Stirling 2007). This fits well with the emphasis on measurement of individual and collective dimensions of democratic agency in food security and nutrition discussed in Article 2.

4.3. Understanding international expertise

The analytical framework of Article 3 (*Science and politics in measuring the SDGs*) takes cues from Lidskog and Sundqvist (2015), which suggests combining analytical tools from science and technology studies (STS) with the epistemic communities concept from international relations. The article thus draws upon two out of the three main theoretical traditions for studying expertise in international affairs (Bueger 2014).

STS studies how science develops in practice. It sees science and technology as inherently *political* in the sense that all practices are informed by and express norms and values (Latour 2012; Jasanoff 2004; Star and Griesemer 1989). International relations has employed tools from STS, but also developed its own concepts to study the role of expertise and science in international affairs (Bueger 2014). I combine the concepts of *epistemic communities* from international relations and *boundary organizations* from STS to analyze the IAEG-SDGs, which is tasked with crafting the SDG indicator framework and consists of statisticians from national statistics offices.

Organizations that have both scientific and political commitments are prevalent in international contexts. The concept of boundary organizations is an STS-concept that can be used to analyze organizations at the interface of research and politics, that facilitate communication and collaboration between the two domains (Guston 1999, 2001). They involve policymakers and researchers and mediate between them, while remaining accountable to both.

The initial conceptualization of boundary organizations by Guston (1999) was built on principal agent-theory (Eisenhardt 1989), which constitutes a political economy approach that analyzes organizational relations through hypothetical contracts between different individuals. The principal agent-theory was combined with the STS-concept of boundary objects (Star and Griesemer 1989). Boundary objects allow members from different communities to work with the objects while maintaining separate identities. It aims to structure the examination of boundary work across science and politics by identifying and characterizing the relationship of actors working across this boundary.

Boundary organizations in this conceptualization stabilize the boundary between science and politics by participating in principle-agent relationships and by creating opportunities and incentives for creating and using boundary objects. In the initial application by Guston (1999), the concept was applied to the empirical case of the Office of Technology Transfers in the United States. The government was conceptualized as a *principal* and researchers as *agents*. In later applications such as Guston (2001), both researchers and policymakers are considered principals with boundary organizations acting as an agent for each, working to serve the interests of both sets of principals.

The initial concept thus implicitly operates with a degree of separation between politics on the one side and science on the other. Boundary organizations exist in between these two distinct realms. Article 3 of this dissertation therefore uses the adapted conceptualization of boundary organizations provided by Miller (2001) and Parker and Crona (2012). Parker and Crona (2012) emphasizes that boundary organizations exist in landscapes of tension with complex institutional environments. They follow Miller (2001) in arguing that boundary organizations are best conceived of as working in a hybrid space where activities of politics and science are deeply intertwined with no clear separation or permanent stabilization of the two. Boundary management should therefore be conceptualized as a process of reconciling tensions among demands of stakeholders who often defy this simple dichotomy. This lack of stability between science and politics is also present within the organization itself, and as established in Article 3 this can even extend to unclear lines between science and politics in the work and self-understanding of individual experts.

The epistemic community concept is a prevalent theoretical concept for the study of science and politics that grew out of the academic field of international relations (Bueger 2014). The concept was inspired by earlier concepts of communities of expertise such as Thomas Kuhn's notion of *paradigm* (Kuhn 1962) and Ludwik Fleck's concept of *thought collective* (Fleck 1935). Peter M. Haas formulated it as a means of exploring the influence of knowledge-based experts in international policy making (Dunlop 2012). It was also used to argue that science is not only a resource that nation-states can employ with no independent role, which has been a common assumption in regime theory (Lidskog and Sundqvist 2015). Haas claimed that science can play an important and independent role by influencing and reformulating the interests of states. This is in turn enabled by the involvement of scientists and experts in policy-processes. International environmental regimes were found by Haas (1992) to be driven not only by state powers, but also epistemic communities that under certain conditions could shape policy.

Haas furthermore proposed a four-aspect system to analyze relevant communities of expertise: (1) shared sets of normative and principled beliefs (2) shared causal beliefs (3) shared notions of validity (4) a common policy enterprise. A mix of principled beliefs, shared notions of validity and expertise thus distinguish the relevant communities of expertise (Haas, 1992: 22).

It is important to keep in mind that the epistemic community is an ideal type that do not simply exist or not exist. The IAEG-SDGs for instance differ from an ideal case of epistemic communities in some crucial ways. Much of the research that uses the concept has focused narrowly on groups of scientists. The article therefore takes cues from less rigid conceptualizations of epistemic communities that are open to include experts and professionals that are not purely scientists and that may be embedded in governance structures (Graz and Nölke 2007; Löblová 2018; Rommetveit, Ballo, and Sareen 2021; Ballo 2015; Cross 2013).

I take particular inspiration from the conceptualization of epistemic communities as networks (Ballo 2015; Rommetveit 2013; Rommetveit, Ballo, and Sareen 2021; Rommetveit et al. 2012). Epistemic networks are distinguished by manner of degree with regards to their fulfillment of the four criteria of Haas (1992). The concept can for instance accommodate more heterogeneous roles and identities across the science-policy interface as well as differing degrees of involvement in policy projects, which tend to be broader and less specific (Ballo 2015). Such networks are thus conceptualized as looser affiliations than epistemic communities (Rommetveit 2013).

There is a longstanding debate on the nature of knowledge in international affairs with so-called positivism standing against constructivist approaches (Wendt 1998; Beaumont and Coning 2022). Haas builds on an understanding of science as disinterested and objective, speaking "*truth to power*" in the sense of countering other actor's inclinations towards short-term action and planning and striving for "*social betterment*" (Rommetveit et al. 2012, p. 4). The epistemic network concept is however more integrative of central lessons from STS: It entails a conceptual acknowledgement of the hybridity of roles across science and policy, with the need for management of the boundaries between them (Rommetveit 2013). Such networks are for instance faced with requirements to comply with the demands of both science and institutions. Their epistemic and normative cores are not perfectly stable, but continuously negotiated and asserted.

According to Lidskog and Sundqvist (2015), the complementarity of the epistemic communities framework and STS is caused by their split focus on so-called *frontstage* activities and *backstage* activities. These arise from the *stage management* concept (Hilgartner 2000), that is tailored to analyze strategies by which science and policy are balanced to present science as an authoritative source for determining what should be done. Science can in close collaboration with policy frame itself as *pure*, with no dimension of politics, values, or normativity. Backstage management refers to the process of crafting scientific knowledge, which is often characterized by contestation, uncertainty and controversies. In front-stage management however, science meets the public and is often portrayed as certain and independent from politics and policy.

The epistemic networks concept brings attention to the shared normative foundations, beliefs, and scientific criteria of a specific group of technical experts that is embedded in a transnational professional and scientific network, constituted by official statistics and national statistical offices. It furthermore fits their dual role of technical experts and decisionmakers. In Article 3, I take further cues from Lidskog and Sundqvist (2015) by using the epistemic networks concept to discern how the *frontstage* separation of science and politics in the SDGs is reflected in the self-interpretation and narratives of a specific group of statisticians. The concept of boundary organization is meanwhile used to discern the crucial features of the continuous boundary work that actually has to be undertaken *backstage* by the same statisticians to protect and project the scientific status of a global indicator process.

5. Conclusion

This dissertation explores how science and politics intertwine in global statistics on food security and nutrition. It particularly emphasizes *how* the complex concepts of food security and nutrition are reduced and idealized through statistics. Like other types of science (Jasanoff 2004; Latour 2012), particular modes of such reduction are always political in the sense that they are informed by and express values and norms. Such statistics moreover represent different *theories of change* with regards to food insecurity and nutrition.

Which dimensions and solution framings of global food insecurity are made dominant through statistics on hunger? Global measurement requires greater idealization due to its inherent complexity. The most prominent international food security indicators chosen to monitor food insecurity in the SDGs render food security legible by framing it in terms of either counting calories or quantifying individual experience. The lock-in of the SDG 2.1 indicators has thus embedded a narrow concept of food security in the major global indicator framework for food security monitoring. This is likely to have significant effects on how food insecurity is addressed nationally and internationally.

Statistical facts do not speak for themselves and must be embedded in structures of power to gain authority and meaning (Porter 1994). Global statistics on food security have served as a vital resource to legitimize and justify the ambitions of the post-World War II development agenda, as well as the position of FAO as a knowledge producer and leading policy agent in development, nutrition, and agriculture. It has made world hunger legible, increasing the visibility of hunger and enabled ease of interpretation of a global problem. It has thus played a key role in establishing a *global legibility* in food security and nutrition that has not only been important for states, but also international organizations and civil society.

Representing by numbers is particularly difficult in cases of multidimensional concepts like food insecurity, where there does not exist consensus on baselines, and no measurements that are exactly right or wrong. The radical inconsistency of such estimates over time does, however, reveal extreme uncertainty, as measurements have changed with technical revisions that have shifted and inverted crucial narratives of global hunger in modern times. Times of crisis have necessitated ad hoc solutions to make numbers show what is in most ways common sense: More people tend to go hungry during periods of drastic food price inflation, global pandemics, or economic recessions.

A crucial motive for making, promoting, and disseminating insecure estimates of food security and nutrition is to encourage action in those areas. To induce a particular kind of intervention, the relevant indicators need to support specific narratives. This makes it important for the indicator to prop up the right story at the right time. As described in Article 1, the MDG-era revisions of the PoU for instance brought UN hunger and poverty-estimates into line. The revision bolstered a narrative of global progress in the era of the MDGs (Pogge 2016), while entirely discarding a recent narrative of crises and a decades-long rise in undernutrition.

Highlighting different aspects of the multidimensional concept of food security through both policy and statistics is crucial in supporting the right kind of interventions into food and nutrition systems. A greater diversity of approaches and data infrastructures are needed to understand and act upon the different drivers of food insecurity. The High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security is arguing for the inclusion of agency and sustainability in the dominant definition of food security (HLPE-CFS 2020), and in related statistics (HLPE-CFS 2022).

Emphasizing agency in food security and nutrition is widely perceived as a way of addressing inequalities caused by food systems (Clapp et al. 2022). These dimensions have however been neglected in policy contexts. Food aid and the science of nutrition have historically been ridden by paternalism on the basis of for instance nationality, gender, race and class (Scott-Smith 2020; Vernon 2007). The inclusion of agency as an element of the scientific and policy definition of food security may act as a catalysator that allows the voices of recipients of food aid to be both heard and counted. Developing statistics on agency could be one possible way to make sure that the democratic rights of recipients of food aid enter into the decision frameworks of those responsible for managing it. Expansion of the food security concept to include agency in academic and policy discourses may thus have real effects for food insecure and malnourished people. Like food security, measurement of agency and sustainability are contested (Alkire 2007; McNeill 2019), even though a plethora of different indicators exist. Although measurement is challenging, such constraints should not be a decisive barrier to their inclusion in science and policy pertaining to food systems (Clapp et al. 2022).

When managing global nutrition or food insecurity, which are issues that entail extreme complexity, including a plurality of perspectives is legitimate and warranted (Funtowicz and Ravetz 1993b, a; Funtowicz and Strand 2007). The SDGs are flattened by a quantitative indicator framework, construed of a misconceived attempt to clinically separate science and policy, and alas they do not manage to embody and express the broad meanings of its targets. Including a more diverse set of actors with decision power may contribute to capturing more of the complexities of food security, nutrition, and sustainable development through quantified indicator regimes.

However, it remains a pertinent question whether or not it is meaningful to compare food security and nutrition across all people and contexts using global indicators. It might be meaningful to measure and compare food security in both developed and crisis-struck countries, but food insecurity in Great Britain and Ethiopia can be conceptually and culturally fairly different. The PoU attempts to solve this by labelling everyone below a threshold of caloric intake as food insecure. The FIES depends on dichotomous responses to eight questions that indicate an experience of food insecurity, and a resulting classification of three levels of severity. Its measurements are in turn converted from national to global scales of food insecurity. It follows that interpretation is an intricate and difficult exercise.

Whether at local, regional, or global level, addressing the knowledge politics of food security indicators remains important. A diversity of approaches and data infrastructures are needed to broaden and open the agenda for sustainable transformations of food systems. The ends of such a transformation should in turn be decided in a genuinely democratic manner, amplifying the voices of those who are systematically disempowered through inequalities within food systems (Leach et al. 2020). Indicators that monitor success should in turn reflect those ends, and not be chosen due to the pathway dominance of certain incumbents and their data infrastructures.

In concluding I would like to encourage future scholarship on historical, political, and conceptual aspects of statistics on food security and nutrition. Science pertaining to food and nutrition remains insufficiently historicized (Nelson, Nisbett, and Gillespie 2021). Despite the efforts of this thesis to chronicle and analyze the politics of global measurement of hunger, a research gap remains. We need to dig deeper to find out what kind of values, norms, theories, and solution framings are concealed in such statistics. Chronicling the development of other forms of food security quantification, such as the methodology of experience-based indicators or the estimation of food waste, is a promising avenue for further empirical analysis. So is studying contested famine classification tools such as the Integrated Phase Classification (IPC) tool.

I also encourage more social and humanistic studies of numbers on a general basis. Quantification concerns everyone and must not remain an exclusive domain of narrow and highly specialized expertise. There is an urgent democratic imperative to check the frequently unchecked powers of the diverse set of quantifying technologies that increasingly record, control, and dominate our lives.

Literature

Agarwal, Bina. 2014. "Food sovereignty, food security and democratic choice: Critical contradictions, difficult conciliations." *Journal of Peasant Studies* 41 (6):1247-1268.

Alkire, Sabina. 2007. "Measuring agency: Issues and possibilities." *Indian Journal of Human Development* 1 (1):169-175.

Andersson, Jens A., and James Sumberg. 2017. "Knowledge politics in development-oriented agronomy." In *Agronomy for Development*, 1-13. Routledge.

Asdal, Kristin, and Hilde Reinertsen. 2021. *Hvordan gjøre dokumentanalyse - En praksisorientert metode*. Oslo: Cappelen Damm Akademisk.

Ballo, Ingrid Foss. 2015. "Imagining energy futures: Sociotechnical imaginaries of the future Smart Grid in Norway." *Energy Research & Social Science* 9:9-20.

Beaumont, Paul, and Cedric de Coning. 2022. "Coping with Complexity: Toward Epistemological Pluralism in Climate–Conflict Scholarship." *International Studies Review* 24 (4):viac055.

Becker, Howard S. 1996. "The epistemology of qualitative research." *Ethnography and human development: Context and meaning in social inquiry* 27:53-71.

Berman, Elizabeth Popp, and Daniel Hirschman. 2018. The sociology of quantification: Where are we now? : SAGE Publications Sage CA: Los Angeles, CA.

Bogden, Robert C., and Sari Knopp Biklen. 1998. "Qualitative research for education: an introduction to theory and methods Needham Heights." *MA: Allyn & Bacon*.

Bourdieu, Pierre. 2004. *Science of science and reflexivity*: Polity.

Bowen, Glenn A. 2009. "Document analysis as a qualitative research method." *Qualitative research journal* 9 (2):27-40.

Bueger, Christian. 2014. "From expert communities to epistemic arrangements: Situating expertise in international relations." In *The Global Politics of Science and Technology-Vol. 1*, 39-54. Springer.

Carson, Kevin. 2011. "Legibility & control: Themes in the work of James C. Scott." *Center for a Stateless Society Paper* 12.

CFS. 2019. CFS Multi-Year Programme of Work (MYPoW) for 2020-2023 Commitee on World Food Security.

Clapp, Jennifer, William G. Moseley, Barbara Burlingame, and Paola Termine. 2022. "Viewpoint: The case for a six-dimensional food security framework." *Food Policy* 106:102164.

Cross, Mai'a. K.D. 2013. "Rethinking epistemic communities twenty years later." *Review of international studies* 39 (1):137-160.

David, Paul A. 1985. "Clio and the Economics of QWERTY." *The American economic review* 75 (2):332-337.

Desrosières, Alain. 1998. *The politics of large numbers: A history of statistical reasoning*: Harvard University Press.

Dey, Ian. 1993. Qualitative research. A user-friendly guide for social scientists. Routledge, London, NewYork.

DiMaggio, Paul. 1997. "Culture and cognition." *Annual review of sociology* 23 (1):263-287.

DiMaggio, Paul. 2014. "Comment on Jerolmack and Khan,“talk is cheap” ethnography and the attitudinal fallacy." *Sociological Methods & Research* 43 (2):232-235.

Dodds, Felix, David Donoghue, and Jimena L. Roesch. 2017. *Negotiating the Sustainable Development Goals - A Transformational Agenda for an Insecure World*. London: Routledge.

Dunlop, Claire A. 2012. "Chapter 19: Epistemic communities." In *Routledge Handbook of Public Policy*, edited by Eduardo Araral Jr et al. Oxford: Routledge.

The Economist. 2022. "The coming food catastrophe." London: The Economist Group.

Eisenhardt, Kathleen M. 1989. "Agency theory: An assessment and review." *Academy of management review* 14 (1):57-74.

Espeland, Wendy.N., and Mitchell L. Stevens. 2008. "A Sociology of Quantification." *European Journal of Sociology* XLIX (3):401-436.

FAO. 1946. First World Food Survey. Washington: Food and Agriculture Organization.

FAO. 1950. Calorie requirements. Report of the Committee on calorie requirements. Rome: Food and Agricultural Organization.

FAO. 1952. Second World Food Survey. Rome: Food and Agricultural Organization.

FAO. 1963. Third World Food Survey. Rome: Food and Agricultural Organization.

FAO. 1977. Fourth World Food Survey. Rome: Food and Agricultural Organization.

FAO. 1987. FIfth World Food Survey. Rome: Food and Agricultural Organization.

FAO. 2022. FAO Food Price Index. Rome: Food and Agricultural Organization.

FAO, IFAD, Unicef, WFP, and WHO. 2022. The State of Food Security and Nutrition in the World. Food and Agriculture Organization, International Fund for Agricultural Development, Unicef, World Food Programme and World Health Organization

FAO, and WHO. 1971. Energy and protein requirements. Report of a Joint FAO/WHO Ad Hoc Expert Committee, Rome, 22 March - 2 April 1971. Food and Agricultural Organization and World Health Organization.

FAO, WHO, and UNU. 1985. Energy and protein requirements. Report of a Joint FAO/WHO/UNU Expert Consultation. Food and Agricultural Organization, World Health Organization and United Nations University.

FAOSTAT. 2022. "Suite of Food Security Indicators." Food and Agriculture Organization.

Fjelland, Ragnar. 2021. "Teaching Philosophy of Science to Science Students: An Alternative Approach." *Studies in Philosophy and Education*:1-16.

Fleck, Ludwik. 1935. *Genesis and development of a scientific fact*. Original edition, 1931. Chicago: University of Chicagor Press.

Foucault, Michel. 1980. *Language, Counter-Memory, Practice: Selected Essays and Interviews.* Ithaca, New York: Cornell University Press.

Foucault, Michel. 2007. *Discipline and punish: The birth of the prison*: Duke University Press.

Freire, Paulo. 2013. *Pedagogy of the oppressed*. Oxford: Routledge.

Friedman, Harriet, and Philip McMichael. 1989. "Agriculture and the state system: The rise and decline of national agricultures, 1870 to the present." *Sociologia ruralis* 29 (2):93-117.

Fujita, Akiko. 2022. "World food shortage going from 'bad to worse,' UN official says." *Yahoo Finance*.

Fukuda-Parr, Sakiko, and Amy Orr. 2014. "The MDG hunger target and the competing frameworks of food security." *Journal of Human Development and Capabilities* 15 (2-3):147-160.

Funtowicz, Silvio O., and Jerome R Ravetz. 1993a. "The emergence of post-normal science." In *Science, politics and morality*, 85-123. Springer.

Funtowicz, Silvio O., and Jerome R Ravetz. 1993b. "Science for the post-normal age." *Futures* 25 (7):739-755.

Funtowicz, Silvio O., and Roger Strand. 2007. "Models of science and policy." In *Biosafety first: Holistic approaches to risk and uncertainty in genetic engineering and genetically modified organisms*, edited by Terje Traavik et al, 263-278. Trondheim: Tapir Academic Press.

Gillespie, Stuart, Lawrence Haddad, Venkatesh Mannar, Purnima Menon, Nicholas Nisbett, Maternal, and Child Nutrition Study Group. 2013. "The politics of reducing malnutrition: building commitment and accelerating progress." *The lancet* 382 (9891):552-569.

Gould, Stephen Jay. 1996. *The mismeasure of man*. New York: W.W. Norton & company.

Graz, Jean-Christophe, and Andreas Nölke. 2007. *Transnational private governance and its limits*. Oxford: Routledge.

Guston, David H. 1999. "Stabilizing the boundary between US politics and science: The role of the Office of Technology Transfer as a boundary organization." *Social studies of science* 29 (1):87-111.

Guston, David H. 2001. *Boundary organizations in environmental policy and science: an introduction*. Los Angeles: Sage Publications.

Hacking, Ian. 1990. *The Taming of Chance*. Cambridge: Cambridge University Press.

Hacking, Ian. 1986. "Making up people." In *Reconstructing Individualism*, edited by Thomas C. Heller and Christine Brooke-Rose. Stanford: Stanford University Press.

Heinen, Sebastian. 2022. "Rwanda's Agricultural Transformation Revisited: Stagnating Food Production, Systematic Overestimation, and a Flawed Performance Contract System." *The Journal of Development Studies*:1-21.

Hilgartner, Stephen. 2000. *Science on stage: Expert advice as public drama*: Stanford University Press.

HLPE-CFS. 2020. Food Security and Nutrition: Building a Global Narrative Towards 2030. In *HLPE Report 15*. Rome: High Level Panel of Experts on Food Security and Nutrition and the Comittee on World Food Security.

HLPE-CFS. 2021. Data collection and analysis tools for food security and nutrition - Online consultation on the V0 Draft of the Report proposed by the HLPE Steering Committee and the Project Team. Rome: High Level Panel of Experts on Food Security and Nutrition and the Comittee on World Food Security.

HLPE-CFS. 2022. Data collection and analysis tools for food security and nutrition - Towards enhancing effective inclusive evidence-informed decision making. Rome: High Level Panel of Experts on Food Security and Nutrition and the Comittee on World Food Security 2021.

Holstein, James A., and Jaber F. Gubrium. 1995. *The active interview*. Vol. 37. Los Angeles: Sage Publications.

Horner, Rory, and David Hulme. 2019. "Global development, converging divergence and development studies: A rejoinder." *Development and Change* 50 (2):495-510.

Haas, Peter M. 1992. "Introduction: epistemic communities and international policy coordination." *International organization* 46 (1):1-35.

Ibreck, Rachel, and Alex de Waal. 2022. "Introduction: Situating Ethiopia in Genocide Debates." *Journal of Genocide Research* 24 (1):83-96.

Ilcan, Suzan, and Lynne Phillips. 2003. "Making food count: expert knowledge and global technologies of government." *Canadian Review of Sociology/Revue canadienne de sociologie* 40 (4):441-461.

IPC. 2022. Somalia: Acute Food Insecurity Situation May 2022 and Projection June to September 2022. Rome: Integrated Phase Food Security Classification.

Jasanoff, Sheila. 2004. "The idiom of co-production." *States of knowledge: The co-production of science and social order*:1-12.

Jasanoff, Sheila, and Sang-Hyun Kim. 2009. "Containing the atom: Sociotechnical imaginaries and nuclear power in the United States and South Korea." *Minerva* 47 (2):119-146.

Jasanoff, Sheila, and Sang-Hyun Kim. 2015. *Dreamscapes of modernity: Sociotechnical imaginaries and the fabrication of power.* Chicago: The University of Chicago Press.

Jerolmack, Colin, and Shamus Khan. 2014. "Talk is cheap: Ethnography and the attitudinal fallacy." *Sociological methods & research* 43 (2):178-209.

Jerven, Morten. 2012. "An unlevel playing field: national income estimates and reciprocal comparison in global economic history." *Journal of Global History* 7 (1):107-128.

Jerven, Morten. 2018. "The history of African poverty by numbers: Evidence and vantage points." *The Journal of African History* 59 (3):449-461.

Kuhn, Thomas S. 1962. *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press.

Kvale, Steinar, and Svend Brinkmann. 2009. *Interviews: Learning the craft of qualitative research interviewing*. Los Angeles: Sage.

Kvangraven, Ingrid Harvold. 2021. "Beyond the stereotype: Restating the relevance of the dependency research programme." *Development and Change* 52 (1):76-112.

Lamont, Michèle, and Ann Swidler. 2014. "Methodological pluralism and the possibilities and limits of interviewing." *Qualitative Sociology* 37 (2):153-171.

Lappé, Frances Moore, Jennifer Clapp, Molly Anderson, Robin Broad, Ellen Messer, Thomas Pogge, and Timothy Wise. 2013. "How we count hunger matters." *Ethics & International Affairs* 27 (3):251-259.

Latour, Bruno. 2012. *We have never been modern*. Harvard: Harvard University Press.

Leach, Melissa, Nicholas Nisbett, Lídia Cabral, Jody Harris, Naomi Hossain, and John Thompson. 2020. "Food politics and development." *World Development* 134: 105024.

Leach, Melissa, Ian Scoones, and Andy Stirling. 2007. "Pathways to Sustainability: an overview of the STEPS Centre approach." STEPS approach paper. Brighton: STEPS Centre, University of Sussex.

Lidskog, Rolf, and Göran Sundqvist. 2015. "When does science matter? International relations meets science and technology studies." *Global Environmental Politics* 15 (1):1-20.

Lie, Einar, and Hege Roll-Hansen. 2001. *Faktisk talt*. Universitetsforlaget.

Löblová, O. 2018. "When epistemic communities fail: exploring the mechanism of policy influence." *Policy Studies Journal* 46 (1):160-189.

Marcus, David. 2003. "Famine crimes in international law." *American Journal of International Law* 97 (2):245-281.

McMichael, Philip. 2009. "A food regime genealogy." *The journal of peasant studies* 36 (1):139-169.

McMichael, Philip. 2014. "Historicizing food sovereignty." *Journal of Peasant Studies* 41 (6):933-957.

McNeill, Desmond. 2019. "The Contested Discourse of Sustainable Agriculture." *Global Policy* 10 (S1):16-27.

Meadows, Donella. 1999. "Leverage points. Places to Intervene in a System." Lynedoch: Sustainability Centre.

Merry, Sally Engle. 2011. "Measuring the World: Indicators, Human Rights, and Global Governance." *Current Anthropology* 52 (3):83-95.

Merry, Sally Engle. 2016. *The seductions of Quantification - Measuring Human Rights, Gender Violence, and Sex Trafficking*. Chicago: The University of Chicago Press.

Merry, Sally Engle. 2019. "The Sustainable Development Goals Confront the Infrastructure of Measurement." *Global Policy* 10:146-148.

Miller, Clark. 2001. "Hybrid management: boundary organizations, science policy, and environmental governance in the climate regime." *Science, Technology, & Human Values* 26 (4):478-500.

Millstone, Erik, John Thompson, and Sally Brooks. 2009. "Reforming the Global Food and Agriculture System: Towards a Questioning Agenda for the New Manifesto." In *Innovation, Sustainability, Development: A New Manifesto*. Brighton: Institute of Development Studies.

Mitchell, Melanie. 2009. *Complexity: A guided tour*. Oxford: Oxford University Press.

Nelson, Erica Marie, Nicholas Nisbett, and Stuart Gillespie. 2021. "Historicising global nutrition: critical reflections on contested pasts and reimagined futures." *BMJ Global Health* 6 (11):e006337.

Nietzsche, F.W. 1887. *On the Genealogy of Morality*. Leipzig: Verlag von C.G. Naumann.

O'Neil, Cathy. 2016. *Weapons of math destruction: How big data increases inequality and threatens democracy*. London: Broadway Books.

Okali, C., James Sumberg, and J. Farington. 1994. *Farmer participatory research*. London: Intermediate Technology.

Parker, John, and Beatrice Crona. 2012. "On being all things to all people: Boundary organizations and the contemporary research university." *Social Studies of Science* 42 (2):262-289.

Patton, Michael Quinn. 1990. *Qualitative evaluation and research methods*. Los Angeles: SAGE Publications, inc.

Pernet, Corinne A, and Amalia Ribi Forclaz. 2019. "Revisiting the Food and Agriculture Organization (FAO): international histories of agriculture, nutrition, and development." *The International History Review* 41 (2):345-350.

Pogge, Thomas. 2016. "The hunger games." *Food ethics* 1 (1):9-27.

Porter, Theodore M. 1995. *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life*. New Jersey: Princeton University Press.

Porter, Theodore M. 1994. "Objectivity as Standardization: The Rhetoric of Impersonality". In *Rethinking objectivity*, edited by Allan Megill, 197-237. Durham: Duke University Press.

Porter, Theodore M. 2020. *The rise of statistical thinking, 1820–1900*. New Jersey: Princeton University Press.

Ravallion, Martin. 2015. *The economics of poverty: History, measurement, and policy*. Oxford: Oxford University Press.

Reed, Isaac Ariail. 2011. *Interpretation and social knowledge: On the use of theory in the human sciences*. Chicago: University of Chicago Press.

Riles, Annelise. 2006. *Documents: artifacts of modern knowledge*. Michigan: University of Michigan Press.

Rocha, Cecilia, and Iara Lessa. 2009. "Urban Governance for Food Security: The Alternative Food System in Belo Horizonte, Brazil." *International Planning Studies* 14 (4):389-400.

Rommetveit, Kjetil. 2013. "Working Paper on Integrated assessments as Epistemic Networks." Deliverable D1.2. EPINET: Integrated Assessment of Societal Impacts of Emerging Science and Technology from within Epistemic Networks.

Rommetveit, Kjetil, Ingrid Foss Ballo, and Siddharth Sareen. 2021. "Extracting users: Regimes of engagement in Norwegian smart electricity transition." *Science, Technology, & Human Values*:01622439211052867.

Rommetveit, Kjetil, Roger Strand, Brian Wynne, Mireille Hildebrandt, Serge Gutwirth, Niels van Dijk, and Cynthia Selin. 2012. " Working Paper on the Concept of Epistemic Networks." Deliverable D1.1. EPINET: Integrated Assessment of Societal Impacts of Emerging Science and Technology from within Epistemic Networks.

Rosenbloom, Daniel. 2017. "Pathways: An emerging concept for the theory and governance of low-carbon transitions." *Global Environmental Change* 43:37-50.

Ross, Corey. 2014. "The plantation paradigm: colonial agronomy, African farmers, and the global cocoa boom, 1870s–1940s." *Journal of Global History* 9 (1):49-71.

Ryan, Gery W, and H Russell Bernard. 2003. "Techniques to identify themes." *Field methods* 15 (1):85-109.

Saltelli, A., and M. Di Fiore. 2023. *Views on Responsible Modelling*. Oxford: Oxford University Press.

Saltelli, A., R. Kattel, A. Andreoni, I.H. Kvangraven, I. Rafos, W. Drechsler, E.S. Reinert, G. Ghosh, A. Stirling, and T. Xu. 2021. "Why ethics of quantification is needed now." In *Working Paper 2021/05*. London: University College London - Institute for Innovation and Public Purpose

Saltelli, Andrea. 2020. "Ethics of quantification or quantification of ethics?" *Futures* 116 (2020): 102509.

Scoones, I., and J. Thompson. 1994. *Beyond farmer first: rural people's knowledge, agricultural research and extension practice*. Bristol: Intermediate Technology Publications.

Scott-Smith, Tom. 2020. *On an Empty Stomach: Two Hundred Years of Hunger Relief*. Ithaca, New York: Cornell University Press.

Scott, J. . 1998. *Seeing like a State: How Certain Schemes to Improve the Human Condition Have Failed*. Yale: Yale University Press.

Skirbekk, Gunnar. 2020. *Epistemic Challenges in a Modern World: From" fake news" and" post truth" to underlying epistemic challenges in science-based risk-societies*. Münster: LIT Verlag Münster.

Spradley, James. 1979. *The ethnographic interview*. Long Grove: Waveland Press, Inc.

Star, Susan Leigh, and James R Griesemer. 1989. "Institutional ecology,translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39." *Social studies of science* 19 (3):387-420.

Stirling, Andy. 2010. Innovation, Sustainability, Development: A New Manifesto. Brighton: STEPS Centre, University of Sussex.

Strand, Roger. 2019. "Vitenskapsteori: What, Why, and How?" In *Social philosophy of science for the social sciences*, edited by Jaan Valsiner, 31-43. New York: Springer.

Strauss, Anselm, and Juliet Corbin. 1990. *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*. Los Angeles: Sage Publications, Inc.

Sukhatme, Pandurang Vasuedo 1961. "The world's hunger and future needs in food supplies." *Journal of the Royal Statistical Society: Series A (General)* 124 (4): 463-508.

Sumberg, James. 2017. *Agronomy for development: The politics of knowledge in agricultural research*. London: Taylor & Francis.

Sumberg, James, and John Thompson. 2012. *Contested agronomy: Agricultural research in a changing world*: Routledge.

Sumberg, James, John Thompson, and Philip Woodhouse. 2012. *Contested agronomy: Agricultural research in a changing world*. In: *Contested agronomy: Agricultural research in a changing world*, edited by James Sumberg and John Thompson, 1-21. New York: Routledge.

Sumner, A. 2022. What is Development Studies? London: European Association of Development Research and Training Institutes.

Tavory, Iddo. 2020. "Interviews and Inference: Making Sense of Interview Data in Qualitative Research." *Qualitative Sociology* 43 (4):449-465.

Taylor, Marcus, Remy Bargout, and Suhas Bhasme. 2021. "Situating Political Agronomy: The Knowledge Politics of Hybrid Rice in India and Uganda." *Development and Change* 52 (1):168-191.

Thévenot, Laurent. 2022. "A new calculable global world in the making: governing through transnational certification standards." In *The New Politics of Numbers*, 197-252. London: Palgrave Macmillan.

UN. 2022. If We Don't Feed People, We Feed Conflict, Secretary-General tells Global Food Security Call to Action Ministerial Event, Warning Mass Hunger Looms. Press release. New York: United Nations.

Vernon, James. 2007. *Hunger: A modern history*. Harvard: Harvard University Press.

Wendt, Alexander. 1998. "On constitution and causation in international relations." *Review of international studies* 24 (5):101-118.

WFP. 2015. Meta Data for the Food Consumption Score (FCS) Indicator. Rome: World Food Programme.

WFS. 1996. Rome Declaration on World Food Security and World Food Summit Plan of Action. Rome: World Food Summit and Food and Agricultural Organization.

Yin, Robert K. 1994. *Case study research: Design and methods*. California: Sage.

Zuboff, Shoshana. 2015. "Big other: surveillance capitalism and the prospects of an information civilization." *Journal of Information Technology* 30 (1):75-89.

Zuboff, Shoshana, Norma Möllers, David Murakami Wood, and David Lyon. 2019. "Surveillance Capitalism: An Interview with Shoshana Zuboff." *Surveillance & Society* 17 (1/2):257-266.

The history of hunger: Counting calories to make global food security legible

Article 1

Abstract

The Prevalence of Undernourishment (PoU) is one of the most central indicators informing the international development agenda. Reported annually by the Rome-based UN agencies in their flagship report The State of Food Insecurity in the World, it is generally considered an authoritative statistic on world hunger. Based on archival research, this article chronicles and analyzes the development of its statistical model and the political and historical context of its revisions. We show that revisions to the PoU model have led to substantial changes in the estimates of the indicator and that this has underpinned shifting policy narratives about trends in the fight against hunger. Ad-hoc revisions were made to render food security crises - associated with inflation, economic recession, and the Covid-19 pandemic - legible. Major changes in the statistical model inverted the PoU's trend lines towards the end of the Millennium Development Goals period. Meanwhile new access to historical datasets from China in the year after China's candidate became Director General in the Food and Agriculture Organization (FAO) in 2019, dramatically reduced estimates of undernourishment in China and the world.

The indicator has thus been shaped by the political and economic structures within which FAO is situated, serving as an important tool to legitimize shifting ambitions

and strategies in the post-World War II development agenda. The UN moreover lacks access to critical national household survey data from the countries with the highest measured undernutrition. At a technical level, this study highlights the need for greater transparency in the data and modelling basis for the PoU. The entanglement of technical and political concerns also illustrates the necessity of critical research on food insecurity quantification. More multifaceted approaches to measure food insecurity are needed.

1. Introduction

The Prevalence of Undernourishment (PoU), first published in 1961, allowed the Food and Agriculture Organization (FAO) of the UN for the first time to report on the number and proportion of people in the world living in hunger. The PoU has since been one of the most prominent international indicators. It was a key indicator in the Millennium Development Goals (MDGs) and it remains a key indicator for Sustainable Development Goal (SDG) 2. Despite its status as a cornerstone of food security measurement, the value and validity of the PoU is contested. It has been criticized on technical grounds for having too long of a reference period (Lappé et al. 2013), for assuming that the basal metabolic rate is the same across different regions (Hayter and Henry 1994), and for overestimating the variability of consumption (Svedberg 2001). Furthermore, the PoU is criticized for its inability to provide estimates below the national level, and for its narrow and technical conceptualization of food insecurity (Fukuda-Parr & Orr, 2014; Pogge, 2016).

Such technical and conceptual concerns also have a political dimension: namely that different ways of measuring food security are informed by and express different values and norms. These values and norms, in turn, may represent different theories of change pertaining to how food insecurity can be reduced. While the history of global poverty statistics such as the dollar a day metric have been subject to significant scholarly attention and debate (Gordon, Pantazis, and Townsend 2000; Ravallion 2015; Jerven 2018), the history of indicators of food security and nutrition have received almost no scrutiny. Furthermore, the PoU and its forerunners not only represented the first attempts to estimate hunger internationally but were pioneering global indicators. Here, we explore the political dimensions of measuring food security by analyzing the history of the PoU through the lens of James Scott's legibility concept.

An entanglement of technical, conceptional and geopolitical dimensions was illustrated by the FAO's substantial revision of the PoU in 2020. This followed the election of China's candidate as Director-General of FAO in 2019, despite a countercampaign by the United States (Chadwick 2019). Following the change in leadership, FAO got access to new data which changed a key variable in the calculation of the PoU for China (Cafiero, Feng, and Ishaw 2020). As seen in Figure 1, this resulted in a significant downward revision of the Chinese (and therefore also the global) hunger estimates (FAO et al. 2020).

The new estimates for China were based on analysis of food consumption and food expenditure data obtained from two separate household surveys that covered the period between 2011 and 2017 (Cafiero, Feng, and Ishaw 2020). Previously the distribution of caloric intake for the Chinese population was based on survey data from 1996 (FAO

1999). Thus, the distribution of caloric intake in China had remained unchanged from 1999 to 2020. The new distribution coefficient of variation resulted in a reduction of the estimated proportion of undernourished people in China from 9.6 to less than 2.5 percent.[4] The revision was the major reason behind the global PoU reduction from 820 million people in 2018 to 690 million people in 2019 and consequently, a downward shift in hunger trend lines towards 2030 (FAO et al. 2019, 2020) (Figure 1). As will become apparent, this was not the first time in the history of the PoU that technical and political factors have been intertwined.

Here we focus on the history of knowledge politics surrounding the PoU. Analyzing the entanglement of knowledge and politics is important not only to assess the validity of global statistics relating to hunger and food insecurity, and to understand how and why certain approaches and actors have come to dominate the systems, but also to identify alternative development pathways (Leach et al. 2020; Taylor, Bargout, and Bhasme 2021; Sumberg and Thompson 2012). The concept of legibility turns our attention to what we see and what we don't see when we measure complex phenomena with indicators, and whose interests the particular measure serves. Through this lens we study what kind of legibility the PoU has offered modern societies, and how the PoU has been shaped by shifting development agendas.

This article proceeds as follows: In section 2, we detail the theory and methods of the article. In section 3, we outline the current methodology for calculating the PoU.

[4] 2.5 percent is the lowest value that the PoU can report.

Section 4 details the historical development of the PoU. Section 5 provides analysis and discussion of these findings before we provide a conclusion in section 6.

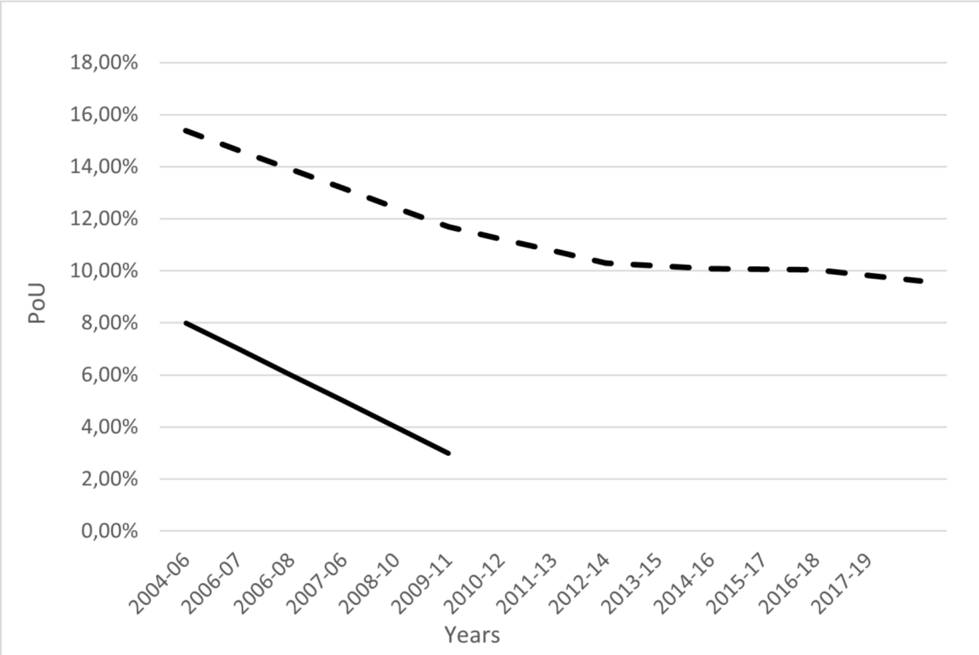

Figure 1 – Prevalence of Undernourishment in the population of mainland China before and after the revision of PoU. The dashed line shows the PoU before the 2020 revision, while the solid line shows the new estimates. Hunger below 2.5 percent of the population cannot be measured by the PoU. According to the new estimates, there has been no undernourishment in China since the 2009/2011 period. Adapted from Cafiero, Feng, and Ishaw (2020).

2. Theory and methods

The most common definition of food security stems from the 1996 World Food Summit (WFS): "*Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life*" (WFS, 1996). This definition encompasses four widely accepted dimensions of food security: *Availability* (adequate food supplies for a given population); *Access* (ability to access available food); *Utilization* (nutritional intake and absorption); and *Stability* (over time). Recently, the High-Level Panel of Experts of the Commission on Food Security suggested that *Agency* (decision power) and *Sustainability* (environmental resilience) should be added to this list of dimensions (HLPE-CFS 2021; Clapp et al. 2022; HLPE-CFS 2020). While the conceptualization of food security has expanded in scope over the years, the demand for simple metrics has remained constant (Barrett 2010; Jones et al. 2013).

There are many ways to theorize the need for and use of metrics in politics. Scott (1998) argued that a central project for the modern state is to make objects and activities more *legible* (or readable, distinguishable, visible). Scott traces this to the Enlightenment which inspired an administrative ordering of nature and society that greatly improved the overview and control of the modern compared to the pre-modern state, with the latter knowing little about its subjects or assets. Expanded legibility in turn supported classic state functions such as taxation and conscription while enabling modern large-scale social engineering. It was ensured by processes as varied as the creation of permanent last names, land registries, standardization of law, language, weights and measures, cadastral surveys, tenure reform and the design of cities (Scott 1998, p.2).

We apply this concept to the emergence of modern statistical technologies. Some core facets of both administrative and scientific legibility are simplification and reduction of complex systems, individuals, and concepts as well as standardization. We seek to understand how quantification of hunger can be seen as a legibility process and what effect that has had on understanding hunger itself.

Numbers are particularly amenable to being framed as objective, neutral and universal, as has been well demonstrated by Theodore Porter (1995). Taking this further, Sally Engle Merry (2016) therefore suggested emphasizing the history and genealogy of quantitative methodologies in order to investigate the development of particular quantitative indicators, which actors and institutions promote and finance them, and how and when they become settled. This paper does this for the PoU, a key indicator of international hunger. The research is archival, and first and foremost based on documents in the FAO library. From 1946 through 1996 FAO published estimates of international hunger in its World Food Survey reports. This report series have with the exception of the Sixth World Food Survey (1996) not been digitized earlier. We have also digitized and analyzed the reports outlining the historical efforts of FAO and later World Health Organization and the United Nations University to make quantitative thresholds for under- and malnutrition at the group level. The digital versions of these documents are now available from the FAO library.[5] Since 1999, these estimates have become a central feature of the annual State of Food Insecurity and Nutrition in the

[5] These documents can be accessed online through the FAO document repository and physically through FAO's David Lubin Memorial Library.

World (SOFI) reports, which are also analyzed. A list of reviewed documents is included in the electronic supplementary material.

That the precision in the global hunger estimates is limited is indicated by FAO, who warns that one should not compare PoU-estimates published in different years due to frequent methodological tweaks and adjustment of trend lines (FAO et al. 2020). There is, however, much to learn from comparing estimates across time with regards to investigating the stability of the PoU's lens. The article therefore compares different time series as well as yearly estimates presented in different report series. We have furthermore been granted insight into the household surveys currently in use to calculate the PoU, including an exhaustive list of surveys, publication year, sample sizes and country coverage. These facts have to our knowledge not been available outside FAO before.

3. The current methodology for determining the PoU

The PoU is an estimate of the proportion of undernourished people in a population, with undernutrition defined as a condition of continued inability to obtain enough food (FAO, 2021a). In the absence of data on the real caloric intake distribution of the individuals in a population, the PoU is a proxy that utilizes data on total availability of calories and a weighted average of caloric requirements, as well as estimates of the distribution (variation) of calory intake within the population. The PoU is given by Equation 1, which presents a notation used by FAO in the recent SOFI reports (FAO et al. 2022, 2018).

$$PoU = \int_{x<MDER} f(x|DEC;CV)dx$$

Equation 1. The PoU.

In Equation 1, x represents individual caloric intake and f(x) is the postulated probability density for an individual to have that caloric intake. The equation defines the PoU as the cumulative density function of individual caloric intake from 0 up to the threshold value for caloric requirement, the so-called MDER, the Minimum Dietary Energy Requirement. In other words, the PoU is the proportion of the area under the density function to the left of the MDER threshold (Figure 2).

An important rationale of this model lies in the scarcity of precise and reliable household survey data on the caloric intake distribution in a population (FAO et al. 2019, p. 149). Equation 1 massively reduces the need for information because it states PoU merely as a function of MDER and the choice of f(x) and its parameters. Currently, the choice of f(x) is the lognormal distribution, which is a two-parameter distribution. In Equation 1, the two parameters are determined by DEC and CV. We shall now turn to how MDER, DEC and CV are estimated.

The MDER is defined as the level of dietary energy (calories) considered necessary for an (average) individual with a normal active and healthy life. The threshold for the entire population is defined as the weighted average of the threshold of the different age or sex groups in the population (FAO, 2003). Demographic data on population structure by sex and age and median height is also used to calculate the MDER (FAO et al. 2022).

DEC is the Dietary Energy Consumption, which is an estimate of the total supply of calories for the national population. DEC divided by the number of individuals in the population is taken to represent the mean individual intake ($\bar{x}$ in Figure 2). Estimates of the total caloric supply is taken from FAO's food balance sheets. These include sources of supply and means of utilization for a range of food items. The total quantity of food production and stocks is added to the net food import. It also defines several sources of utilization, such as livestock feed, seeds, manufacture for food or non-food purposes, losses, and food supplies available for consumption (FAOSTAT 2022).

CV is the coefficient of variation (CV) taken to represent the relative standard deviation of caloric intake. It provides a measure for inequality in food consumption within the population. The CV has two components: 1) CV|y is estimated from variability in food consumption attributed to differences in income, and 2) CV|r is estimated from variability that comes from non-socioeconomic factors such as such as sex, age, body mass and physical activity (Wanner, Cafiero, Troubat, & Conforti, 2014). CV|y is estimated using nationally representative household survey data on income, expenditure, or food consumption. When no suitable survey data is available, the indicator Food Insecurity Experience Scale (FIES) is used to calculate the CV|y (FAO et al. 2022).

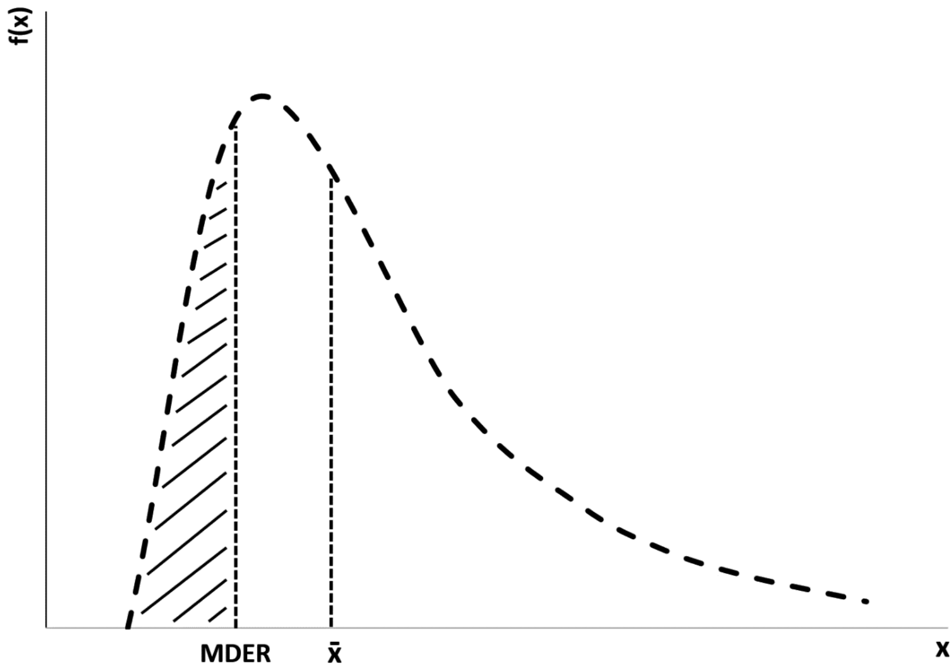

Figure 2 – The lognormal probability density function of the PoU. Adapted from Naiken (2002). $\bar{x}$ is the mean of the distribution. The PoU equals the (shaded) aggregate area to the left of the MDER.

4. The contested history of the PoU

Measuring food production and food security has been a central task of the FAO since its inception. Table 1 provides an overview of milestones in the development of its estimation methods. We proceed to give a chronological account of the development of FAO's estimates of global undernutrition and their methodological techniques. The story largely revolves around the estimation of national availability of calories, the caloric intake distribution in the population, and caloric requirement thresholds (which the DEC, CV and MDER from equation 1 are intended to calculate).

Year	Report	Development	Scope	Undernutrition in population
1946	WFS-1	First global estimates of undernutrition Invariable caloric thresholds No estimation of distribution of caloric intake	World	50%
1952	WFS-2	First use of food balance sheets to estimate caloric intake First application of reference man technique for estimating caloric thresholds for undernutrition No estimation of distribution of caloric consumption	World	59%
1963	WFS-3	First application of Sukhatme's (1961) technique in WFS-series due to estimation of distribution of caloric intake Attained basic structure of PoU	World	10 % to 15 %
1974	SOFA	Used caloric thresholds specified by BMR Estimates minimum proportion of undernourished Introduction of theoretical probability distribution (beta) of caloric intake in population	Developing countries	25 %

1977	WFS-4	First systematic publication of country-level data Distribution of caloric intake calculated based on survey data on food consumption and income and expenditure data.	Developing countries	25 %
1987	WFS-5	Changed to log-normal probability distribution of caloric intake. Introduction of CV, which requires less data to calculate than the entire caloric intake distribution. Applies two unique undernutrition threshold BMR-values	Developing countries	15 % or 23 %
1996	WFS-6	PoU largely assumed its contemporary form and terminology Applied survey reference period equal to one year Last of WFS-report	Developing countries	20 %
1999	SOFI	Launch of the annual State of Food Insecurity (SOFI)-report series	Developing countries	18 %
2009	SOFI	Largest estimate of global undernourishment in absolute terms (1020 millions undernourished) Use of data from USDA to provide forecast for 2009	World	15,7 %

2012	SOFI	Including estimates of food loss at retail levels Skew-normal probability distributions introduced replacing lognormal distribution	World	14,9 %
2017	SOFI	Introduction of FIES as alternative global indicator Used to support calculation of CV|y where preferred kinds of household data is missing	World	11 %
2020	SOFI	China revision drastically reduces number of undernourished in China and globally. Skew-normal distribution replaced by lognormal	World	8,9 %
2021	SOFI	Use of FIES data to project 2020 estimates in order to project consequences of COVID 19-pandemic Presents values in both point estimates and range	World	9.2 % to 10.4 % (9,9 % middle value)

Table 1 –Methodological milestones in the development of global estimates of undernutrition. The most recent estimates are often predictions of the recent past or contemporary situation. The SOFI 2009 estimate was calculated using the global population estimate provided in the report, as it did not provide percentage estimates for 2009.

4.1.1. Early estimation of global undernutrition

Figure 3 provides an overview of its estimates of the proportion of undernourishment globally from start of the World Food Survey-series until its end in 1996 and replacement by the SOFI reports. The SOFI-series will be covered in the last section of the analysis.

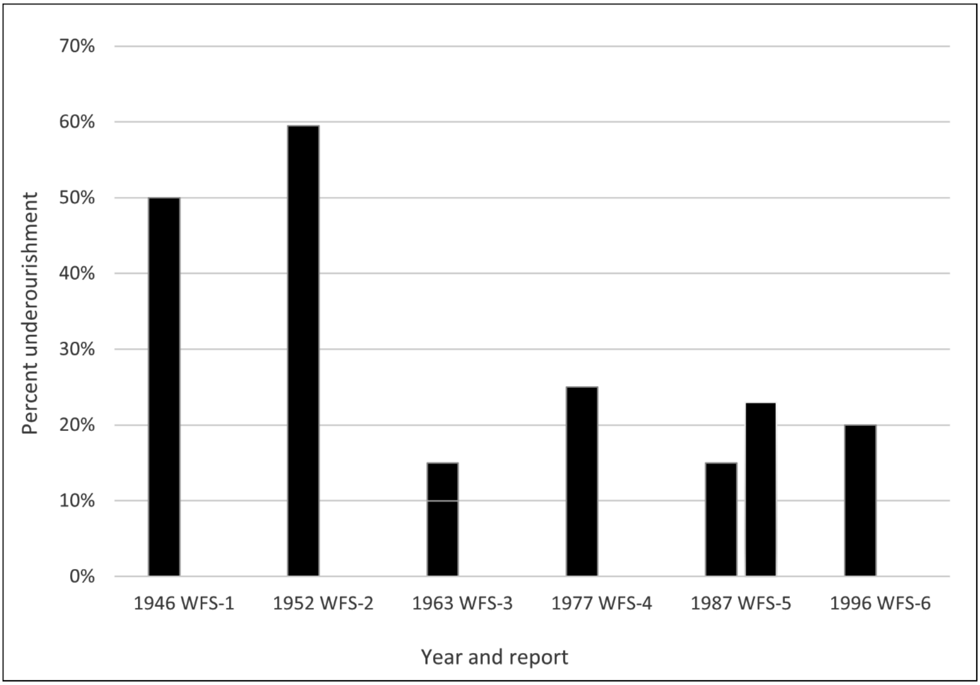

Figure 3 –Undernutrition measured globally by World Food Surveys in the period 1946-1996. WFS-1 and WFS-2 operated with fixed caloric thresholds for global estimates. PoU's-methodology introduced from WFS-3, which also provided its estimates in a range. WFS-5 published estimates using two different caloric thresholds.

One of FAO's first major accomplishments was the publication, only a few months after its establishment, of the First World Food Survey (1946). Covering 70 countries and about 90 percent of world population, this represented the first time facts and figures had been systematically assembled to assess global hunger (FAO 1952). Pre-war data were used to estimate average per capita calorie availability (see DEC in equation 1), but for many countries information on population and food supply were little more that guesswork (FAO 1963). Populations were divided into groups consuming above 2750 calories, between 2250 and 2750 calories, and below 2250 calories. The data that was used was not adjusted for variability in caloric needs within these groups or across different countries. For countries with lower average food availability than 2250 calories, the whole population was thus counted as undernourished.

The Second World Food Survey (1952) made use of data from the postwar period. It incorporated some innovation both in terms of data sources and methods. FAO's new Food Balance Sheets were used to estimate prewar and postwar food supplies available for human consumption. WFS-2 also used household survey data in order to triangulate its estimates of food supplies.

However, the second survey's most substantial innovation was probably its new calorie requirement scale. This scale took mean environmental temperature, body weight and distribution by age and sex in a population into account when defining caloric thresholds, similar to the modern MDER (see equation 1). This was the beginning of nationally determined calorie requirements, in contrast to the uniform caloric standards applied by WFS-1 (FAO 1950). The scale was based on defining a 'reference' man and woman of a specific age and weight, living a healthy and active life in a specific mean annual temperature. With the exception of physical activity level, the scale adjusted for all these factors in different national contexts. The actual per capita requirement for each country was obtained by multiplying the requirement of each age and sex group by the proportion of the people in different groups. This requirement scale was applied for national estimates, but not for the global estimation, which still relied on a fixed caloric threshold of 2200 calories (FAO 1952, p. 11).

4.1.2. The making of the PoU

In 1961, FAO's chief statistician, Pandurang Vasudeo Sukhatme, published a pioneering estimate of the extent of hunger in the world that represented the introduction of the PoU. While there have been important developments in the PoU that will be elaborated upon in the coming sections, its basic structure remains largely unchanged. The critical innovation was the application of population-level caloric intake distributions (example provided in Figure 3). They were added to the food balance sheets (used to estimate the DEC) and caloric requirement scale used in WFS-2 (Sukhatme 1961)[6] that FAO already utilized.

As explained in section 3, this distribution added a measure of inequality in caloric intake in the population, caused in part by socioeconomic differences. Data used to establish the new caloric intake distributions were derived from household surveys

[6] The MDER and CV concepts were introduced later, and have slightly different meanings, even though they are also tools to calculate the variable national caloric thresholds and the shape of the distribution of caloric intake in the population.

based on either recall of food consumed in a reference period, or actual weighing of foodstuffs. Sukhatme (1961) employed the previously described 'reference man' technique to calculate quantitative thresholds for undernutrition.

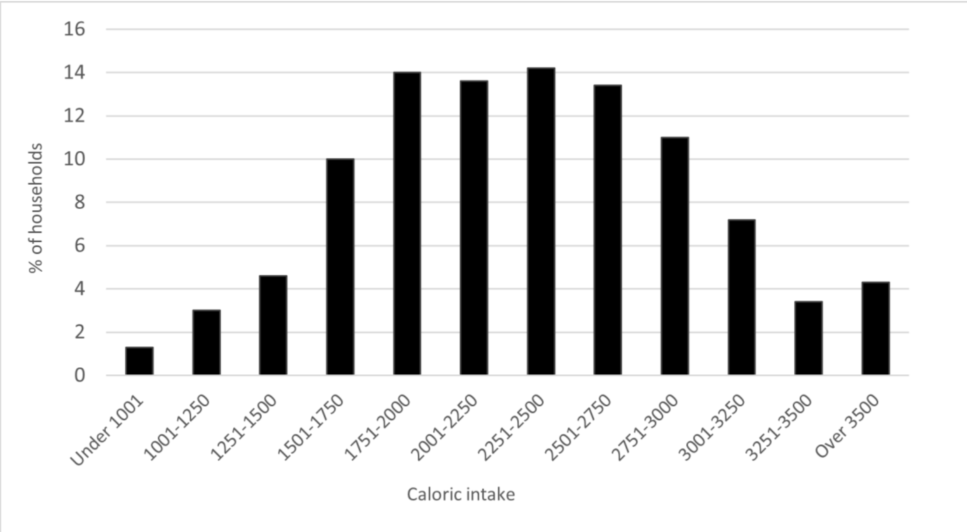

Figure 4 – Distribution of caloric intake from survey of 843 households in colonial India. No theoretical probability distribution is applied. The difference to the lognormal shape of Figure 2 is readily apparent. Figure by the authors based on data presented in Sukhatme (1961).

The indicator developed by Sukhatme (1961) was at its introduction praised not mainly for the certainty of its estimates, but because it endowed international estimates of undernutrition with scientific authority. Although the estimates were critiqued for their uncertainty and for being presented with too little epistemic humility (George 1961, p. 509), the model's methodological innovations were praised for opening up a new frontier for statistics (Searle 1961, p. 514). Statistics such as national income were at the time considered to entail important "*demonstration effects*" for industrialized countries that newly decolonized countries also aspired to (Seers 1959, p. 38). One commentator hailed the new mode of legibility offered by the PoU by referring to the historical impact of such economic statistics: "*if we consider the early history of National Income and Expenditure Statistics it seems clear that unless a start had been made with what would now be regarded as limited data such work would not now be considered of fundamental importance to efficient government policy making*" (Moss 1961, p. 518). The reference to statistics' ability to set governance agendas seems prescient in hindsight.

This debate further shows that numbers are used not only because of their ability to describe the world, but also because of their ability to configure politics (Porter 1994). Sukhatme (1961, p. 464) put his work in the context of the Freedom From Hunger Campaign (FFHC). This campaign was a global information campaign on hunger, and an essential precursor to the modern development movement (Bunch 2007). It was largely motivated by a sentiment that the world hunger problem was getting worse and that rapid population growth compounded the problem. The FFHC sought to promote research, education, and action on global hunger.

The Third World Food Survey, which for the first time utilized the new methods to measure international undernourishment, was a key part of the Campaign. WFS-3 was orchestrated by FAO Director-General Binay Ranjan Sen, who also initiated the FFHC. As the first WFS report based on the PoU, WFS-3 has been framed as the first accurate and scientific documentation of hunger and undernourishment in the WFS series

(Bunch 2007). WFS-3 covered the prewar, postwar, and contemporary periods, and provided the first estimates of global undernutrition using the methodology established by Sukahtme in 1961. It used food balance sheet data for over 80 countries covering some 95 percent of the world population to calculate the DEC (see equation 1), and drew more heavily and directly than earlier WFS editions on household surveys of food consumption. As seen from Figure 3, its estimate of global undernutrition was far lower than in previous reports. The integration of caloric intake distributions made it possible to differentiate between varying consumption in different parts of national populations, triggering a significant reduction of estimates compared to previous surveys.

At its peak, the FFHC had more than 100 national committees all over the world, with broad participation by groups and individuals from all parts of the social and political spectrum. A pioneering element of the campaign was the collaboration with NGOs, industry, and youth movements. The WFS-3 thus played a key part as a knowledge resource in a campaign that would be important in spurring the formation of international development as we know it today (Bunch 2007, p. 47), in particular through promoting broad partnerships. In this way it helped bridge a gap between philanthropy, activism, and official development programmes. The campaign was also an important means of transforming FAO, then a mainly technical organization, into a broader development agency.

4.4 Further development of the PoU

The State of Food and Agriculture (1974) and WFS-4 (1977) represented ambitious attempts to further improve the estimation of undernutrition. The reports have perhaps therefore been regarded as the first proper application of a model that closely resembles the version of the PoU in use today (Cafiero et al. 2014), despite the cautious application of the Sukhatme-model already in WFS-3.

The State of Food and Agriculture (1974) report concluded that in many countries the PoU had declined following the Second World War. A main methodological update was adjustments to the notion of the *reference man* in line with the suggestions provided by the joint Ad Hoc Expert Committee on Energy and Protein Requirements by FAO and WHO (1971). The committee advised that the Basal Metabolic Rate (BMR) should be used to denote thresholds for undernutrition, since most of the energy utilized by the body is basal metabolism. The chosen BMR rate made no allowance for physical activity in order to remove risk of overestimation so in contrast to the WFS-3 from 1963 the State of Food and Agriculture 1974 thus explicitly stated that it reported the *minimum* proportion of undernourished in the population. Caloric intakes were compared to the lowest limit of needs rather than average requirements. The real number of undernourished people was therefore likely to be much higher.

In the same report, a beta probability distribution was applied to the calorie intake for each country. Using a beta distribution rather than the more common normal distribution requires the settlement of lower and upper limits of the caloric intake range for individuals in a fixed interval. The beta distribution thus enabled some standardization by warding off extreme and unrealistic values of caloric intake. The use of theoretical probability distributions in general also provided a framework for generating such distributions when data were lacking, reducing the role of scarce survey data in calculating the distribution of caloric intake in the population (FAO 1987, p. 63).

The Fourth World Food Survey (1977) largely employed the technical framework presented in the State of Food and Agriculture with some important adaptations. WFS-4 estimated undernutrition for 70 countries covering 90 percent of the world population, for the first time publishing national data for a comprehensive group of countries. The distribution of caloric intake was for the first time calculated not only based on household food consumption surveys. When food consumption data was unavailable, data on income and expenditure was introduced.

The Fifth World Food Survey (FAO 1987) abandoned the beta probability distribution in favor of the two-parameter log-normal distribution which remains in use today (FAO et al. 2022). The methodology section showed that the log-normal distribution gave the highest scoring representation of empirical data of caloric intake distributions. The *fitting* of a log-normal distribution onto each country requires the estimation of the standard deviation of per capita calorie intake to calculate the CV, as specified in equation 1.

Based on reviews of human nutritional requirements by FAO, the World Health Organization and United Nations University (1985), WFS-5 also introduced adjustments to caloric requirements. The report applied used two different BMR thresholds, reflecting different interpretations of observed variation of weight maintenance requirements. Estimates using both thresholds showed a slight increase in absolute numbers of undernourished in developing countries during the 1970s, while the proportion of undernourished declined.

The Sixth World Food Survey (1996), the last of the series, came out just before the landmark World Food Summit and helped frame the summit's debates and deliberations. From 1999, the series would be replaced by the annual flagship reports State of Food Insecurity (SOFI). In WFS-6, the PoU largely assumed its contemporary form and terminology, despite several tweaks made after the end of the WFS-series. Due to the availability of new data following the end of the cold war, China and what were referred to as the former *Asian centrally planned economies* were included in the survey after decades of exclusion. The WFS-6 also included anthropometric indicators like wasting, stunting and body mass index to triangulate alternate measures of undernutrition.

For the first time a standardized survey reference period, equal to one year, was used. For an individual to count as undernourished, s/he should thus have experienced lack of average daily sufficient caloric intake for an entire year. WFS-6 also tried to take seasonal variation into account, and to avoid unrealistic values by imposing upper and lower limits in the calculation of the CV. Some important changes were introduced in the calculation of caloric thresholds. WFS-6 introduced the MDER-term described in equation 1. It still used the BMR for denoting caloric cutoff points, while employing a weighted average of sex-age group specific cutoff points to establish caloric thresholds. The group-specific cutoff-points equaled the lowest level of an acceptable range of acceptable caloric intake, calculated following guidelines established by FAO, WHO, and UNU (1985). The BMR now included an allowance for light physical activity.

4.5 SOFI and the 1 billion hungry

Since its first publication in 1999 until now, the State of Food Insecurity (SOFI) report series published annually by FAO and its partner agencies has been the home of the PoU. There were no significant methodological changes in the PoU from 1999 until after 2010 (Wanner et al. 2014, p. 6). The SOFI reports published between 2003 and 2007 showed that the PoU had been on the rise since the mid-90s, which was claimed to be a historical low point (FAO 2003, 2004, 2006, 2007). The SOFIs of 2008, 2009 and 2010 continued this narrative of increasing hunger, underpinned by an increasing PoU, emphasizing how rapidly increasing food prices, financial crisis and economic recession apparently had devastating effects on undernutrition (FAO 2008b; FAO and WFP 2009, 2010).

The 2008/09 food price crisis was said to have further increased the number of undernourished people from 848 million in 2006 to 923 million in 2007 (FAO 2008b). Then in 2009, the SOFI announced a further jump to 1,020 million (FAO and WFP 2009). For its 2009 estimate, FAO used projections from a food security model developed and operated by the United States Department of Agriculture (USDA) Economic Research Service. By referring to these projections, FAO claimed that the impact of the financial crisis was expected to increase the number of undernourished by 9 percent from the previous year, on top of an increase of 2 percent due to other factors. The model projected caloric intake in 70 low-income countries, on the basis of commodity groups. The projections used in SOFI (2009) were based on a modelled scenario that integrated a 25 percent cutback in capital flows for low-income countries as well as reduced export incomes and food imports.

The estimate of 1 billion was explained by both the food price and financial crises. According to the Director-General of FAO, "*a dangerous mix of the global economic slowdown combined with stubbornly high food prices in many countries*" had pushed some 100 million more people into chronic hunger and poverty – the highest number of hungry people ever to walk the earth – leaving one sixth of humanity undernourished (FAO 2009). References to one billion hungry began appearing in speeches, media reports and advocacy campaigns around the world, while millions signed an online petition prompting governments to address the "*1 billion hungry*" (Provost 2012).

There was, however, considerable external skepticism about FAO's estimates. Following a presentation of the 2010 SOFI, the Committee of World Food Security (CFS) agreed an external evaluation of the PoU's estimation methods was needed. The evaluation had a particular emphasis on data quality and quantity, but also urged FAO to improve its parameters and its underlying probabilistic model by performing new tests of probability distributions (CFS 2011a, b). Following the evaluation, CFS "*strongly recommended"* FAO to improve upon its estimates of undernourishment with a particular emphasis on the "*timeliness and reliability of the underlying data and parameters*" (CFS 2011c, p. 13). The PoU was further criticized for using a narrow definition of food insecurity, neglecting welfare losses due to the sacrifice of other essential consumption to maintain minimum caloric intakes, and for not considering micronutrients (Wanner et al. 2014, p. 7). Following this critical evaluation, FAO chose not to release new figures in 2011, and removed the 2009 and 2010 estimates (FAO and WFP 2011). The development of a core set of complementary food security indicators that could capture different elements of food insecurity was recommended (FAO 2012). The PoU's role and reputation as the leading indicator of international food security was coming under serious scrutiny.

In the SOFI 2012 FAO introduced a number of changes to the methodology and data basis for estimation (FAO, WFP, and IFAD 2012). The most impactful change was the lowering of caloric intake with empirically estimated coefficients that reflected national food loss at retail level (FAO 2011). It had not been previously integrated and implied a significant reduction of available calories across the board. New skew-normal theoretical probability distributions that allowed for more asymmetry in caloric intake were introduced. In line with these new distributions, household survey data was used to estimate a new parameter of skewness of the distribution, that could reflect asymmetry in the distribution of caloric intake. In 2020 FAO returned to using a lognormal distribution (FAO et al. 2020), after a period of applying both probability distributions selectively.

The new methodology was used from 2012 and onwards and applied retroactively to the period covering the MDG era. The net effect of these methodological changes increased the estimated number of undernourished at the start of the time series when compared to the pre-adjustment trend line, while decreasing estimates from 2000 and onwards (FAO, WFP, and IFAD 2012). A wide range of new data was added. National food balance sheets used to estimate the DEC were re-estimated up to 2009. FAO used more income and expenditure surveys to recalculate distributions of caloric intake. Height data was adjusted leading to a re-estimation of the threshold MDER for each country which led to a reduction of estimates across the board. Population data revisions with significant changes in populous countries like China and Bangladesh further increased the baseline number of undernourished.

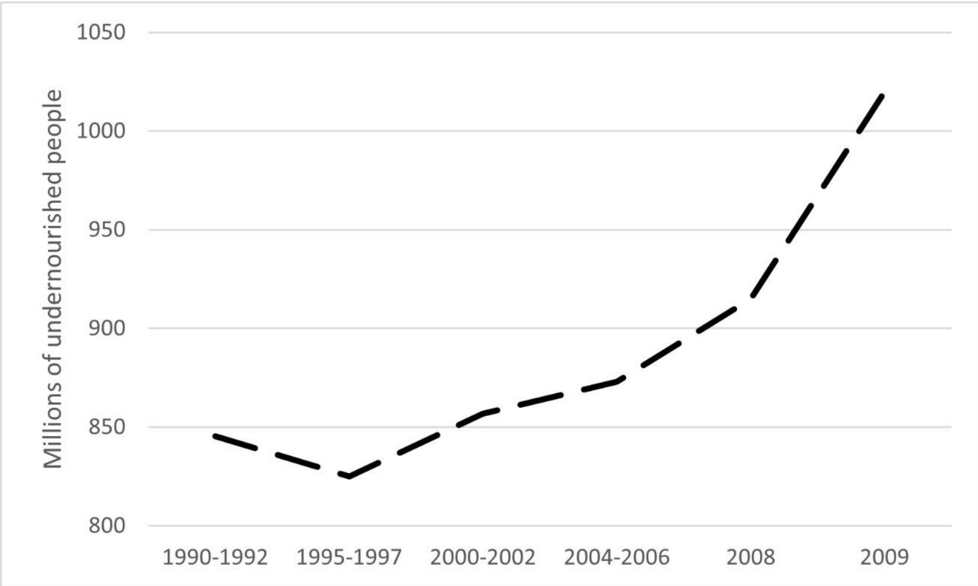

Figure 5 – Prevalence of Undernourishment reported in the period 1990-2009 in SOFI (2009). The 2009 value is a projection based on an ad-hoc revision of the statistical method done in connection with the 2007-2008 food prize crisis. Figure by the authors based on data from SOFI 2009.

FAO would declare a 45 percent reduction in hunger in developing countries by the end of the MDG era in 2015, compared to the baseline in 1990. Thus, the goal of reducing the proportion of hungry people by 50% had very nearly been reached. FAO thus drastically revised its method for estimating undernourishment towards the tail end of the MDG era, changing estimation techniques and revising its estimates back to the start of the MDG monitoring period. The outcome was an inverted trend line and narrative of global hunger.

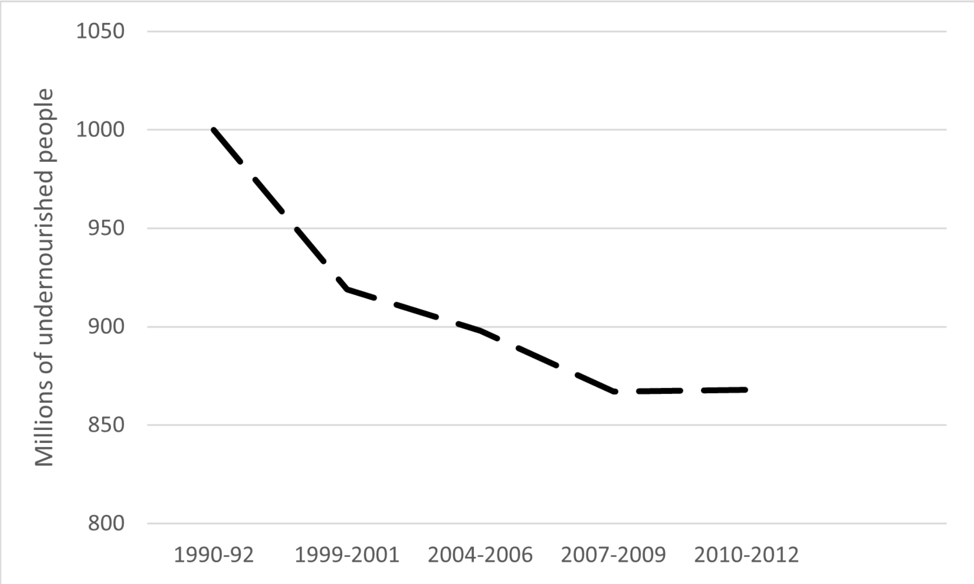

Figure 6 – Prevalence of Undernourishment reported by FAO in the period 1990-2012 after the 2012 revision of the methodology. Figure by the authors based on data from SOFI 2012.

The old technique suggested that the food crises pushed a historic 1 billion into hunger in 2009, with enormous increases from 2007 to 2009. The new method, however, suggested that there were no significant effects of the crisis or of the *great recession* that followed. On the contrary, the new estimates showed a reduction in the number of undernourished – from 885 million in 2004 to 2006 to 852 million in 2007 to 2009. The negative effects of the food and financial crises, which were at center stage in previous SOFI-reports (FAO and WFP 2009; FAO 2008b), were thus expunged from a trend line that now supported a clear narrative of progress in the fight against hunger and poverty during the MDG period (Pogge 2016). The new PoU estimates told a story of significant reduction in hunger since 1990, a story that was entirely consistent with MDG ambitions.

We end our historical account by describing the PoU's loss of hegemony as a technology for rendering international food insecurity legible. In 2017, the experience-based indicator FIES was included in SOFI with global estimates of the number and proportion of *food secure or marginally insecure* or *severely food insecure* (FAO et al. 2017). As of 2019, SOFI also included FIES estimates of *moderate or severe food insecurity* (FAO, et al., 2019). It is available in individual and household versions.

FIES' estimates have also been heavily used to support the calculation of the CV|y of the PoU. For countries where no suitable survey data is available, the CV|y is currently indirectly estimated using changes in severe food insecurity as measured by the FIES where data is available (FAO et al. 2022). The indicator has also been used in forecasting the most recent estimates of the PoU, as FIES' estimates tend to be available earlier than the preferred sources of household data (FAO et al. 2018). This has particularly made it crucial in forecasting the impact of the Covid 19-pandemic (FAO et al. 2021, 2022). Normally the changes if CV|y are derived from three-year averages. However, the pandemic in 2020 and the years that followed were considered so exceptional that the estimate for 2020 was used on its own and contrasted to the average estimate from 2017-2019. FAO furthermore carried out a sensitivity analysis of how much changes in severe food insecurity as measured by FIES is caused by changes in CV|y. The outcome was a broad interval between one third and one, prompting FAO to publish the overall PoU-estimates in a range (FAO 2021). FAO's two leading methodologies for measuring international food security are thus becoming increasingly integrated.

4.6 The current data basis for determining the PoU

The increasing availability of survey data produced by different international agencies and national authorities has been a crucial enabler of the international estimates of the PoU. However, getting access to sufficient survey data remains a significant challenge for FAO. If China lacked updated socioeconomic survey data for two decades, how can we trust that the data basis is much better for other countries? Estimating global undernutrition will always be very difficult. It is therefore particularly important that estimates are publicly transparent with regards to their exact estimation technique and data basis.

The biggest hindrance to evaluating the PoU is that its estimates are produced by a black box. FAO in the recent SOFI reports gives a very general mathematical formula for its modelling (see equation 1). It has defended the MDG reversal by pointing out that new data had revealed so far unknown progress in efforts against hunger, but these data and the basis for their calculation were and still are unavailable for public scrutiny.[7] This is particularly the case for the household survey data used to estimate the CV|y, which FAO does not make public. It has, however, published some aggregated information. In 2022, the agency for instance stated that it uses 118 surveys from 60 countries to calculate the socioeconomic distribution of intake (FAO et al. 2022).[8] The agency does not publish or make available complete lists of surveys, what kind of surveys they are, their sample size, or when they were undertaken. This lack of transparency breaks with the recommendations of a recent report authored by the High Level Panel of Experts on Food Security and Nutrition for international organizations and other relevant actors to "*comply with open access principles for data analysis and tools, ensuring access to and reproducibility of relevant research results*" (HLPE-CFS 2022, p. 107).

The data are particularly scarce for countries that are highly food insecure. FAO has survey data for only 24 out of 46 countries commonly regarded as Least Developed Countries (LDCs), which tend to be the worst affected by food insecurity. Much of the LDC data is furthermore dated. Ten of the countries solely have data from 2005 or before, including populous countries such as Zambia and Venezuela. For six of these countries, FAO only has access to survey data that is older than the Chinese household survey data were at the time of the revision (Cafiero, Feng, and Ishaw 2020). The

[7] In its own metadata, FAO only marks whether estimates are produced by itself, official sources, other international actors, are not available or have not been published (FAOSTAT, 2022).

[8] This excludes FIES surveys, which are used to estimate CV|y if the preferred household survey data on food consumption, income or expenditure is not available.

average sample size for surveys from LDCs used to calculate the CV|y is furthermore significantly smaller at 11 360 households than the average of 15 626 for all surveys.

Figure 7 visualizes the level of food security in LDCs and FAO's access to household data. As shown, the countries with the highest levels of food insecurity tends to have very scarce access to household surveys. This is also evident if we look at specific examples: Out of the ten countries with the highest measured prevalence of undernutrition in SOFI (2022), FAO has survey data for only Haiti, Liberia, and Rwanda with a single survey each. Only Rwanda in turn has survey data that is less than 15 years old. Haiti's data is from 1999, the same year as the survey data used for China before the revision (Cafiero, Viviani, and Nord 2018). The legibility provided by the PoU is thus founded on much less data for the countries that have the most acute need of food security aid and intervention, providing another clear argument for greater transparency and facilitation of reproduction of research results.

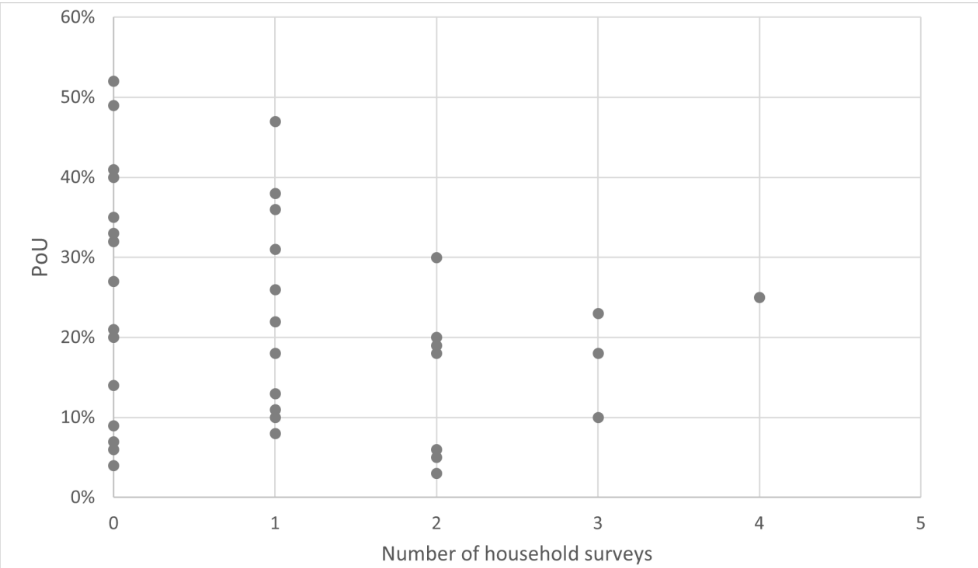

Figure 7 – Number of household surveys and PoU in LDCs. Estimates extracted from SOFI (2022), which had no estimate for Guinea, Burundi, Burkina Faso, Eritrea, Mozambique, Somalia, South Sudan, Tuvalu, Uganda.

5. Discussion

The PoU has for a long time been one of the most prominent global development indicators. In the coming section, we discuss what kind of legibility it has offered modern societies. This discussion takes the historical account of its technical development outlined in the previous section as its starting point.

5.1. The right narrative

The significant revisions of the PoU in recent decades question the integrity of the model's estimates. For the dramatic MDG reversal of hunger estimates, part of the explanation could be that the PoU has become a crucial advocacy tool. This makes it important for the indicator to tell the right story at the right time.

In the turmoil of the food price and financial crisis, the important and opportune story was one of record hunger that urgently needed to be addressed and relieved. At the end of the MDG-era it was one of global progress led on by the UN and the international community. The trend of increasing hunger was at the time not in line with the World Bank's poverty indicator which declined during the MDG period (Pogge 2016). As the sun set on the MDGs and it was time to judge what progress had been made, the very recent narrative of crises and a decades-long consistent rise in undernutrition was entirely discarded by technical adjustments. They brought the hunger and poverty-estimates into line and bolstered a narrative of global progress in the era of the MDGs. According to Pogge (2016), this alignment was a key move in legitimizing broad UN development efforts as well as a neoliberal political order by changing the PoU's lens to harmonize hunger trends with poverty numbers. Access to new survey data from China in 2020 meanwhile enabled FAO to provide verification of the Chinese government's narratives of social progress under authoritarian rule.

The three greatest shifts in PoU estimates have since the start of SOFI occurred in the wake of significant data updates and methodological tweaks. The provision of Chinese survey data was the main factor in the most dramatic revision of SOFI estimates to date, driving a global reduction of the number of undernourished by over 16 percent (FAO et al. 2019, 2020). The dramatic increases in projections of SOFI (2009) to over 1 billion undernourished on a backdrop of the financial and food price crisis was fueled by an ad hoc integration of projections from USDA-modelling, causing almost 10 percent increase in the number of undernourished from SOFI (2008). The COVID 19-projections meanwhile pioneered greater use of FIES-estimates in calculating the PoU in SOFI (2021), recording an increase of the number of undernourished of 12 percent from SOFI (2020).

Increase in hunger during a pandemic is expected, but the methodological changes needed to capture these developments highlights the struggle of the PoU to detect the big crises of the global food system. One of the causes of its inability to capture ongoing crises is the lack of incorporation of price data in the PoU's estimates (FAO, WFP, and IFAD 2012). It remains to be seen whether the PoU will manage to represent the effects of the spiking food price inflation and turmoil in world markets following the invasion of Ukraine in 2022.

5.2. A vague and productivist lens

The PoU at its introduction established a new and global mode of legibility, the forcefulness of which was combined with remarkable vagueness. As Scott (1998, p. 12) points out, creating legibility tends to require the creation of simplified objects that displace actual human beings and their complexities. The PoU operates at a high level of abstraction, yielding only national, regional, and global estimates - the actual hungry person is replaced by undernourished populations and national averages. It says little about who the hungry are or where they are located.

Due to this inability to disaggregate, the PoU can do little to guide policy at the national or local level. As a result it has done much less to enhance legibility of food insecurity for national or local decisionmakers than for agencies with global mandates and responsibilities. Its impact rather came through legitimizing communication efforts and advocacy measures. The PoU produced scientifically credible estimates and stylized facts about the problem of hunger, such as a substantial part of the world population being undernourished and most of them living in developing countries.

The indicator was from its inception a part of a productivist paradigm for agricultural development and food security. On the eve of the Green Revolution, Sukhatme (1961) provided a range of estimates of how much production would need to increase to offset or improve upon the food security situation following projected population growth. He concluded that food supplies needed to double by 1980 and triple by 2000 to support even a moderate improvement in nutrition. The PoU and the associated reports thus provided an important scientific and political legitimation of the productivist paradigm that characterized much of agricultural development in the 20th century.

The PoU is completely dependent on counting calories. Although food balance sheets in principle should include domestic production both inside and outside the agricultural sector (FAO 2022), some types of food production are very difficult to register or measure. For example, subsistence farming, meat from wild animals, insects, home gardens, agroforestry, wild edible plants, and harvesting of indigenous edible plants are often overlooked (FAO 2008a). They are, however, substantial sources of nutrients in many low and middle-income contexts, which agricultural statistics has historically been slow to adapt to (Hill 1984). Different kinds of food plants can also be placed in a hierarchy of legibility. Rice and wheat are crops that have historically been easy for states to tax, whereas roots or tubers are less legible for the state (Scott 2010). So are mixed crops, which are more difficult to measure than monocrops (Hill 1984). As mentioned above, estimates of food waste at the retail levels have become integrated in the PoU. This is also the case for waste at the household level (FAO et al. 2020, p. 202). Losses during pre-harvest and harvest stages are however not included (FAO 2008a, 2019).

The PoU is also productivist in the sense that quantified calories by construction link energy input to output, connecting the intake of food to capacity for labor (Scott-Smith 2020). As the food security discourse evolved to become more concerned with socioeconomic access to food, FAO developed its undernourishment estimation to better account for this dimension of the phenomenon by including and refining estimates of the distribution of intake of calories in the population.

The narrow focus on caloric undernourishment, however, requires a bracketing that keeps other variables in the food system out of sight. A prime example of this is the *sustainability* dimension of food security, which is becoming increasingly important in food security discourse (Westengen and Banik 2016; HLPE-CFS 2021). The other new food security dimension proposed by the HLPE, *agency*, is also not captured. The PoU has previously been criticized for framing food insecurity as an issue of supply and production, marginalizing complex socio-economic determinants, human development and human rights priorities (Fukuda-Parr and Orr 2014). Another crucial aspect of food security that disappears when using the PoU is malnutrition in terms of micronutrient deficiencies (Pogge 2016). The quantification of global undernutrition thus provides an illustrative case: it shows us that rendering society legible requires displacement of complex human beings and systems, so that they will fit neatly into the idealized schemes of science.

6. Conclusions

Measuring global hunger is fraught with radical uncertainty along several axes. The legibility provided by the PoU has repeatedly been changed by technical adjustments that have shifted and inverted crucial narratives of global hunger in modern times. The indicator has been unable to capture recent crises, prompting a series of extensive and at times ad hoc revisions of its own estimation technique. Trend lines have not just shifted upwards or downwards from year to year but flipped within short time frames to craft wildly different narratives of international hunger for the same periods of history. The data basis for its estimation is moreover highly fragmented, as is well illustrated by how the countries that suffer the highest measured undernutrition have the poorest data basis. This instability in the estimates of the PoU show the need for greater transparency and facilitation of reproduction of results. There is fortunately substantial and easily attainable potential for improving transparency by disclosing to the public underlying data, further modelling details and previous time series.

The model introduced by Sukhatme (1961) was perceived as legitimate and credible due to its advanced scientific technique. Models that are mainly used for advocacy purposes, however, also need to tell the right story. The estimates of the PoU have been molded by the power dynamics and political economy that its host organization is situated in, serving to justify the position and ambitions of FAO. As such, the PoU is also an indicator of the changes in the agri-food development agenda over the last 60 years, from the public sector based Green Revolution of the 60s and 70s to the rise of the neoliberal agenda in the 80s and the last decades' private sector focused New Green Revolution (Sumberg and Thompson 2012; McMichael 2009; Friedman and McMichael 1989). FAO's choice of how to *see* the world is tightly connected to and has been an efficient tool to serve its specific needs as an evolving organization.

When there is a laser focus on measuring caloric undernutrition, it is furthermore worth considering exactly what aspects of food security fall outside FAO's field of vision. Two examples are the elements of democratic agency and sustainability, which are rapidly gaining importance in food policy and science (HLPE-CFS 2020, 2021). By serving as a legitimating tool for promoting productivism, the map provided by the PoU has shaped the terrain and contributed to make it more visible through promoting types of agricultural modernization that tends to lead to production in bigger units. These are in turn more easily measured by caloric accounting.

Indicators can also have indirect effects on governance, such as the substitution of broader political goals with indicator that is intended to monitor its progress (Merry 2016). The PoU risks providing perverse incentives by nudging governments toward an emphasis on the production and intake of more calories, as increasing caloric availability is likely to be perceived as a more easily attainable policy goal than reducing socioeconomic inequality. Insufficient national availability of food is generally not considered the main reason for undernutrition or famine (De Waal 2017; Sen 1981). Rather, the main enforcer of hunger is poverty (Svedberg 1999).

Literature

Barrett, Christopher B. 2010. "Measuring food insecurity." *Science* 327 (5967):825-828.

Bunch, Matthew James. 2007. "All Roads Lead to Rome: Canada, the Freedom From Hunger Campaign, and the Rise of NGOs, 1960-1980." PhD, History, University of Waterloo.

Cafiero, Carlo, Juan Feng, and Adeeba Ishaw. 2020. Methodological note on new estimates of the Prevalence of Undernourishment in China. In *FAO Statistics Working Paper Series*. Rome: Food and Agricultural Organization.

Cafiero, Carlo, Hugo R Melgar-Quinonez, Terri J Ballard, and Anne W Kepple. 2014. "Validity and reliability of food security measures." *Annals of the New York Academy of Sciences* 1331 (1):230-248.

Cafiero, Carlo, Sara Viviani, and Mark Nord. 2018. "Food security measurement in a global context: The food insecurity experience scale." *Measurement* 116:146-152.

CFS. 2011a. CFS Rountable on Monitoring Food Security. In *Tecnical Background Paper*. Rome: Commitee on World Food Security.

CFS. 2011b. Outcome of "Roundtable to review methods used to estiamte the number of hungry" (FAO, 12-13 September 2011. Rome: Commitee on World Food Security

CFS. 2011c. Thirty-seventh Session - Final Report. Rome: Committee on World Food Security.

Chadwick, Vince, 2019. "Chinese candidate takes FAO top job amid US concerns." Devex.

Clapp, Jennifer, William G. Moseley, Barbara Burlingame, and Paola Termine. 2022. "Viewpoint: The case for a six-dimensional food security framework." *Food Policy* 106:102164.

De Waal, Alex. 2017. *Mass starvation: The history and future of famine*. New Jersey: John Wiley & Sons.

FAO. 1946. First World Food Survey. Washington: Food and Agriculture Organization.

FAO. 1950. Calorie requirements. Report of the Committee on calorie requirements. Rome: Food and Agricultural Organization.

FAO. 1952. Second World Food Survey. Rome: Food and Agricultural Organization.

FAO. 1963. Third World Food Survey. Rome: Food and Agricultural Organization.

FAO. 1974. State of Food and Agriculture. Rome: Food and Agricultural Organization.

FAO. 1977. Fourth World Food Survey. Rome: Food and Agricultural Organization.

FAO. 1987. FIfth World Food Survey. Rome: Food and Agricultural Organization.

FAO. 1996. Sixth World Food Survey. Rome: Food and Agricultural Organization.

FAO. 1999. State of Food Insecurity in the World. Rome: United Nations Food and Agricultural Organization.

FAO. 2003. State of Food Insecurity in the World. Rome: Food and Agricultural Organization.

FAO. 2004. State of Food Insecurity in the World. Rome: Food and Agricultural Organization.

FAO. 2006. State of Food Insecurity in the World. Rome: Food and Agricultural Organization.

FAO. 2007. State of Food Insecurity in the World. Rome: Food and Agricultural Organization.

FAO. 2008a. Food Balance Sheets - A handbook. Rome: Food and Agricultural Organization.

FAO. 2008b. State of Food Insecurity in the World. Rome: Food and Agricultural Organization.

FAO. 2009. "1.02 billion people hungry." Press release. Rome: Food and Agricultural Organization.

FAO. 2011. Global food losses and food waste. Rome: Food and Agricultural Organization.

FAO. 2012. Proceedings - International Scientific Symposium on Food and Nutrition Security Information: From Valid Measurement to Effective Decision Making. Rome: Food and Agriculture Organization.

FAO. 2019. State of Food and Agriculture - Moving forward of food loss and waste reduction. Rome: Food and Agriculture Organization.

FAO. 2021. "Voices of the Hungry - Frequently Asked Questions." Rome: Food and Agricultural Organization.

FAO. 2022. "Food Balance Sheets - Background." Rome: Food and Agricultural Organization.

FAO, IFAD, Unicef, WFP, and WHO. 2017. The State of Food Security and Nutrition in the World. Food and Agriculture Organization, International Fund for Agricultural Development, Unicef, World Food Programme and World Health Organization.

FAO, IFAD, Unicef, WFP, and WHO. 2018. The State of Food Security and Nutrition in the World. Food and Agriculture Organization, International Fund for Agricultural Development, Unicef, World Food Programme and World Health Organization.

FAO, IFAD, Unicef, WFP, and WHO. 2019. The State of Food Security and Nutrition in the World. Food and Agriculture Organization, International Fund for Agricultural Development, Unicef, World Food Programme and World Health Organization.

FAO, IFAD, Unicef, WFP, and WHO. 2020. State of Food Security and Nutrition in the World. Food and Agriculture Organization, International Fund for Agricultural Development, Unicef, World Food Programme and World Health Organization.

FAO, IFAD, Unicef, WFP, and WHO. 2021. The State of Food Security and Nutrition in the World. Food and Agriculture Organization, International Fund for Agricultural Development, Unicef, World Food Programme and World Health Organization.

FAO, IFAD, Unicef, WFP, and WHO. 2022. The State of Food Security and Nutrition in the World. Food and Agriculture Organization, International Fund for Agricultural Development, Unicef, World Food Programme and World Health Organization

FAO, and WFP. 2009. State of Food Insecurity in the World. Rome: Food and Agricultural Organization and World Food Programme.

FAO, and WFP. 2010. State of Food Insecurity in the World. Rome: Food and Agricultural Organization and World Food Programme.

FAO, and WFP. 2011. State of Food Insecurity in the World. Rome: Food and Agricutlural Organization and World Food Programme.

FAO, WFP, and IFAD. 2012. State of Food Insecurity in the World. Rome: Food and Agricultural Organization, World Food Programme and International Fund for Agricultural Development.

FAO, and WHO. 1971. Energy and protein requirements. Report of a Joint FAO/WHO Ad Hoc Expert Committee, Rome, 22 March - 2 April 1971. Rome: Food and Agricultural Organization and World Health Organization.

FAO, WHO, and UNU. 1985. Energy and protein requirements. Report of a Joint FAO/WHO/UNU Expert Consultation. Food and Agricultural Organization, World Health Organization and United Nations University.

FAOSTAT. 2022. "New Food Balances." Rome: Food and Agricultural Orgnization.

Friedman, Harriet, and Philip McMichael. 1989. "Agriculture and the state system: The rise and decline of national agricultures, 1870 to the present." *Sociologia ruralis* 29 (2):93-117.

Fukuda-Parr, Sakiko, and Amy Orr. 2014. "The MDG hunger target and the competing frameworks of food security." *Journal of Human Development and Capabilities* 15 (2-3):147-160.

George, R.F. . 1961. "Discussion on Dr. Sukhatme's paper." *Journal of the Royal Statistical Society: Series A (General)* 124 (4): 508-510.

Gordon, David, Christina Pantazis, and Peter Townsend. 2000. "Absolute and overall poverty: a European history and proposal for measurement." *Breadline Europe: The measurement of poverty*: 79-105.

Hayter, June E., and Christiani Jeyakumar Henry. 1994. "A re-examination of basal metabolic rate predictive equations: the importance of geographic origin of subjects in sample selection." *European Journal of Clinical Nutrition, 48*, 702-707.

Hill, Polly. 1984. "The poor quality of official socio-economic statistics relating to the rural tropical world: with special reference to south India." *Modern Asian Studies* 18 (3):491-514.

HLPE-CFS. 2020. Food Security and Nutrition: Building a Global Narrative Towards 2030. In *HLPE Report 15*. Rome: High Level Panel of Experts on Food Security and Nutrition and the Comittee on World Food Security.

HLPE-CFS. 2021. Data collection and analysis tools for food security and nutrition - Online consultation on the V0 Draft of the Report proposed by the HLPE Steering Committee and the Project Team. Rome: High Level Panel of Experts on Food Security and Nutrition and the Comittee on World Food Security.

HLPE-CFS. 2022. Data collection and analysis tools for food security and nutrition - Towards enhancing effective inclusive evidence-informed decision making. Rome: High Level Panel of Experts on Food Security and Nutrition and the Comittee on World Food Security 2021 Rome: .

Jerven, Morten. 2018. "The history of African poverty by numbers: Evidence and vantage points." *The Journal of African History* 59 (3):449-461.

Jones, Andrew D., Francis M. Ngure, Gretel Pelto, and Sera L. Young. 2013. "What are we assessing when we measure food security? A compendium and review of current metrics." *Advanced Nutrition* 4:481-505.

Lappé, Frances Moore, Jennifer Clapp, Molly Anderson, Robin Broad, Ellen Messer, Thomas Pogge, and Timothy Wise. 2013. "How we count hunger matters." *Ethics & International Affairs* 27 (3):251-259.

Leach, Melissa, Nicholas Nisbett, Lídia Cabral, Jody Harris, Naomi Hossain, and John Thompson. 2020. "Food politics and development." *World Development* 134:105024.

McMichael, Philip. 2009. "A food regime genealogy." *The journal of peasant studies* 36 (1):139-169.

Merry, Sally Engle. 2016. *The seductions of Quantification - Measuring Human Rights, Gender Violence, and Sex Trafficking*. Chicago: The University of Chicago Press.

Moss. 1961. "Discussion on Dr. Sukhatme's paper." *Journal of the Royal Statistical Society: Series A (General)* 124 (4): 518-520.

Naiken, Loganaden. 2002. "FAO methodology for estimating the prevalence of undernourishment." Proceedings of the International Scientific Symposium on Measurement and Assessment of Food Deprivation and Undernutrition. Rome: Food and Agricultural Organization.

Pogge, Thomas. 2016. "The hunger games." *Food ethics* 1 (1):9-27.

Porter, Theodore M. 1995. *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life*. New Jersey: Princeton University Press.

Porter, Theodore M. 1994. "Objectivity as Standardization: The Rhetoric of Impersonality". In *Rethinking objectivity*, edited by Allan Megill, 197-237. Durham: Duke University Press.

Provost, Claire. 2012. "Global hunger: do the figures add up?" *The Guardian*, Global Development.

Ravallion, Martin. 2015. *The economics of poverty: History, measurement, and policy*. Oxford: Oxford University Press.

Scott-Smith, Tom. 2020. *On an Empty Stomach: Two Hundred Years of Hunger Relief*. Ithaca, New York: Cornell University Press.

Scott, James C. . 1998. *Seeing like a State: How Certain Schemes to Improve the Human Condition Have Failed*. New Haven, Connecticut: Yale University Press.

Scott, James C. 2010. *The art of not being governed: An anarchist history of upland Southeast Asia*. New Haven, Connecticut: Yale University Press.

Searle, W.F. 1961. "Discussion on Dr. Sukhatme's Paper." *Journal of the Royal Statistical Society: Series A (General)* 124 (4): 514-515.

Seers, Dudley. 1959. "An Approach To The Short-Period Analysis Of Primary-Producing Economies." *Oxford Economic Papers* 11 (1):1-36.

Sen, Amartya K. 1981. Poverty and Famines - An Essay on Entitlement and Deprivation. Oxford: Oxford University Press.

Sukhatme, P.V. 1961. "The world's hunger and future needs in food supplies." *Journal of the Royal Statistical Society: Series A (General)* 124 (4):463-508.

Sumberg, James, and John Thompson. 2012. *Contested agronomy: Agricultural research in a changing world*. Oxford: Routledge.

Svedberg, Peter. 1999. "841 Million Undernourished?" *World Development* 27 (12):2081-2098.

Svedberg, Peter. 2001. "Undernutrition Overestimated." Seminar Paper No. 693. Stockholm: University of Stockholm.

Taylor, Marcus, Remy Bargout, and Suhas Bhasme. 2021. "Situating Political Agronomy: The Knowledge Politics of Hybrid Rice in India and Uganda." *Development and Change* 52 (1):168-191.

Wanner, Nathan, Carlo Cafiero, Nathalie Troubat, and Piero Conforti. 2014. Refinements to the FAO methodology for estimating the Prevalence of Undernourishment indicator. In *ESS Working Paper No. 14-05, September 2014*. Rome: Food and Agricultural Organization.

Westengen, Ola, and Dan Banik. 2016. "The State of Food Security: From Availability, Access and Rights to Food Systems Approaches." *Forum for Development Studies* 43 (1).

Measuring the End of Hunger: Knowledge Politics in the Selection of SDG Food Security Indicators

Article 2

ABSTRACT

Ending world hunger remains one of the central global challenges, but the question of how to measure and define the problem is politically charged. This article chronicles and analyses the indicator selection process for SDG 2.1, focusing in particular on the Food Insecurity Experience Scale (FIES) indicator. Despite alleged efforts to separate political and technical aspects in the indicastor selection process we find that they were entangled from the start. While there was significant contestation around which indicators should be selected, the process was characterized by pathway lock-in: The complexity of food security quantification and the resource constraints in the process favored already established data infrastructures and milieus of expertise, locking in the position of FAO and its established food security indicators. The SDG 2.1 indicators frame food insecurity in terms of caloric supply and demand and individual experience, arguably excluding dimensions of democratic agency, sustainability and other dimensions and drivers of food insecurity. The lock-in has thus embedded a narrow concept of food security in the major global indicator framework for food security monitoring. This is likely to have significant effects on how food insecurity is addressed nationally and internationally. Addressing the knowledge politics of food security indicators is important to broaden and open up the agenda for food system

transformations. Statistics and indicators are important tools in this agenda, but a diversity of approaches and data infrastructures from the local to the international level are needed to understand the multiple dimensions and drivers of food insecurity.

1. Introduction

The UN member states have agreed to end hunger by 2030. This ambitious goal is the second of the 17 Sustainable Development Goals (SDGs) adopted in 2015. SDG 2 boldly aims to "*End hunger, achieve food security and improved nutrition and promote sustainable agriculture*". It consists of eight targets and 14 indicators. The process of selecting indicators to measure progress towards SDG 2 was characterized by knowledge politics from the outset, with the complexity of measuring food security and scarce global data locking in certain indicators.

The standard definition of food security stems back to the 1996 World Food Summit (WFS): "*Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life*" (WFS, 1996). This definition is multidimensional and difficult to quantify (Barrett, 2010; Westengen and Banik, 2016). Food security indicators may focus on food *availability* (adequate food supplies for a given population), *access* (ability to access available food), *utilization* (nutritional intake and absorption), *stability* (over time), or a combination of these (Jones et al. 2013; Upton, Cissé, and Barrett, 2016). Recently, the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security (CFS) proposed to update the definition to also include the dimensions *agency* (decision power) and *sustainability* (environmental resilience) (HLPE-CFS, 2020).

Given the multidimensionality of food security it is difficult to identify suitable quantitative indicators (Maxwell, Vaitla, and Coates, 2014). The concept *indicator* refers to systematic, comparative organization of information that allows for comparison among units or over time (Merry, 2016). While targets and goals specify objectives, indicators are supposed to quantify progress towards them. However, indicators and goals are often conflated. Indicators can thus influence both knowledge and governance (Merry, 2016; Völker, et al., 2019). The effects of SDG indicators, including those on food security and agriculture, have global impact (Fukuda-Parr and McNeill, 2019).

Each Goal of the 17 SDG has several quantified targets, which in turn are measured by indicators. The first five targets of SDG 2 (2.1–2.5), are related to food security and agricultural sustainability. The last three (2a–2c) are market-related targets. This article investigates the process of selecting food security indicators for SDG Target 2.1: "*By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.*" Two food security indicators were selected to monitor this target. The first is the Prevalence of Undernourishment (PoU) indicator developed by the UN agency Food and Agricultural Organization (FAO). This is FAO's traditional indicator used to monitor food security and hunger at national and global levels. The second indicator is the household level experienced-based food security indicator Food Insecurity Experience Scale (FIES), developed by the FAO in 2013. FAO serves as both SDG indicators' custodian agency, with the responsibility to design their data collection and reporting system.

Figure 1 shows the global measurements of food insecurity based on PoU and FIES from 2014 to 2020.[9] The difference in underlying concepts of food security and measurement methods for the two indicators results in considerably different figures of global hunger and food insecurity. Measured with the PoU indicator, 768 million people suffered from undernourishment globally in 2020. Measured with FIES, approximately 2.4 billion people suffered from moderate or severe food insecurity in 2020, and 928 million of these were classified as severely food insecure (FAOSTAT, 2022).

Agri-food systems are increasingly subject to scholarly attention with regards to the power relationships and politics involved (Leach, et al., 2020). The field of political agronomy focuses on contestation in agricultural research, a discipline traditionally regarded as an objective and technical discipline focused on practical problems (Sumberg, 2017; Sumberg and Thompson, 2012). Political agronomy aims to unearth the knowledge politics of how agronomy is constructed as a discipline and practice, illustrating the tensions within the discipline's self-representation as a purely evidence-based science removed from questions of values, context, and politics (Taylor, Bargout, and Bhasme, 2021). The politics and history of quantification of food security has hitherto received much less scholarly attention. We address this gap in the field of food security statistics, arguing that the SDG indicator selection process locked in FAO's

[9] Global data collection for FIES was initiated in 2014.

indicators and that this has consequences for food security policy and practice that deserves more debate.

The first objective is to investigate how food security indicators were selected to monitor the SDGs, as well as how they frame food security. The second objective of the article is to provide an empirical evaluation of the role of politics in food security measurement. The article proceeds as follows: First, we present the theory of path dependence and the methods employed in this study. Second, we present approaches to measure food insecurity. Third, we present our analysis. Finally, we conclude and draw key policy lessons.

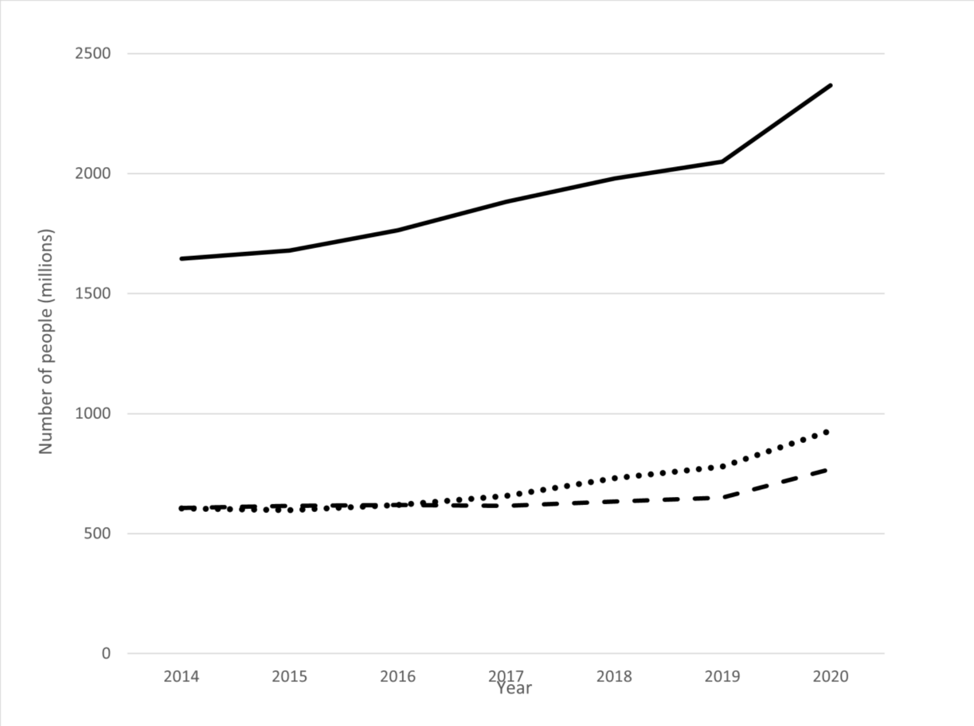

Figure 1. Measurements of global food insecurity by SDG 2.1 indicators (FAOSTAT, 2022). The solid line indicates number of people affected by moderate or severe food insecurity globally (FIES). The dotted line indicates number of affected by severe food insecurity (FIES). The dashed line indicates number undernourished people (PoU).

2. Theory and Methods

The term "path dependency" was initially conceived to describe how the initial advantage of specific actors or random shocks determine how the history of a phenomenon unfolds (David, 1985). This concept of path dependency was cast in terms of initial probabilism and eventual determinacy in outcomes. We apply the concept of organizational path dependence which frames path dependency as a progressive elimination of the scope of decision making (Sydow, Schreyögg, and Koch, 2009). In this perspective present and future scopes for action are limited by previous choices, but not pre-determined. A minimum condition for breaking a lock-in is the effective restoration of choices. The development of organizational path dependence is defined as a three-stage process of (1) preformation phase, (2) formation phase and (3) lock-in phase.

The preformation phase can be characterized as an open situation with no significant restrictions on the scope of action. The preformation phase however does not start from scratch. The transition to the formation phase is triggered by an event leading to a critical juncture. This phase is typically characterized by the emergence of a narrower organizational path caused by self-reinforcing mechanisms, constituting a certain pattern of social practice which increasingly dominates the alternatives. The formation phase thus favors a particular type of decision or action pattern. The transition to the lock-in phase is characterized by a further restriction of the scope for choices, replicating the action pattern even more. This lock-in may be of a cognitive, normative, and resource-based nature. Organizational processes are not likely to amount to a full state of determinacy, but rather self-reinforcing dynamics that brings about a certain action pattern which gets deeply embedded in practice and hence replicated.

To explore the mechanisms that enforce certain pathways in food security quantification, we refer to the knowledge politics of food (Sumberg, Thompson, and Woodhouse, 2012; Taylor, et al., 2021), and engage with perspectives presented by Leach et al. (2020) on pathways in food science and technology. Power and politics infuse the food system. The playing fields of food science and technology are not level, as the distribution of power influences the scientific pathways and direct them to fit the interests of presiding actors. Lack of diversity in potential pathways for food science and technology can in turn enforce pathway lock-in. This brings our attention to the dominant interests in food quantification as well as the democratic, social and sustainability outcomes of the prevalent pathways of food security quantification.

Furthermore, we take inspiration from Merry (2016)'s approach to developing genealogies of indicators, combining in-depth interviews with archival analysis in an effort to investigate the process of selecting food security indicators to monitor the SDGs. The article draws on 15 in-depth interviews with key informants from the *Inter-agency and Expert Group on SDG Indicators* (IAEG-SDGs), which is the body that is mandated with crafting an indicator framework for the SDGs, as well as national statistical offices, bureaucracies, diplomatic missions and UN agencies. It also includes a review of 53 documents from the SDG indicator selection process. A list of documents is included in the electronic supplementary material.

Our attention is directed to the role of custodian agencies drawn from the UN and other international organizations in shaping the indicator framework. Interviewees were therefore chosen to gather information on the role of custodian agencies in developing the indicator framework from a range of perspectives by key actors at different levels of the SDG process. The selection includes statisticians and policy professionals working on food security in all the Rome-based UN organizations, statisticians from national statistical bureaus that are members or observers in the IAEG-SDGs as well as bureaucrats in national ministries and diplomatic missions.[10] This wide variety of relevant backgrounds ensures a plurality of perspectives and accounts of the process of selecting indicators for SDG target 2.1. All interviews were conducted on a prior informed consent basis. The individuals interviewed are anonymized. The interviews were semi-structured and to a large extent process-oriented (Tavory, 2020), emphasizing the how, who, when, and where of the SDG indicator selection process. The NVIVO software was used to identify, organize, and code relevant themes for the purpose of data analysis. To Ryan and Bernard (2003, p. 87), the terms *theme* and *expression* connote the fundamental concepts we are trying to describe when analyzing. They describe themes as conceptual linkages of expressions. The specific themes identified in the analysis of interview material will be elaborated upon in the coming section.

3. Path Dependency in SDG Indicator Selection

We find that the process of SDG 2.1 indicator selection corresponds with the general phases of organizational path dependency. This path dependency was caused in part by constraints on resources and data infrastructures. The outcomes in terms of knowledge politics are analyzed at the end of the section.

[10] The Rome-based organizations are Food and Agriculture Organization (FAO), World Food Programme (WFP) and International Fund for Agricultural Development (IFAD). They constitute the lead international agencies for food security.

3.1 The SDG 2.1 indicators

To set the stage for the discussion of path dependency and knowledge politics in the SDG indicator selection process, we here briefly outline the history and measurement methods of the two indicators chosen to monitor SDG Target 2.1.

The FAO has since its establishment in 1945 been the key player in providing statistics on food and agriculture. However, the quality of these statistics has been the subject of wide-ranging criticisms (Berry, 1984; Hill, 1984; Nature Plants, 2019). With the establishment of the SDGs, FAO arguably increased its importance as custodian of agri-food system statistics. The organization is designated custodian agency for SDG 2 and has custodian responsibility for 9 out of 14 SDG 2 indicators (UNSC, 2021). In addition, FAO is responsible for compiling and verifying country data and metadata for 22 SDG indicators and contributes to another five (UNSD, 2021). The two key indicators of special interest here, FIES and PoU, are both produced by FAO and purport to measure access to food (FAO, 2013, 2016). They are however based on different methodologies and conceptualizations of food security, which in turn lead to rather different measurements of food security (see figure 1). As a basis for understanding potential implications of different approaches to measure SDG 2.1 progress, we first outline their technical foundations.

The PoU chosen as SDG indicator 2.1.1 is FAO’s flagship indicator. It was first published by Sukhatme (1961) and was also previously a key indicator for the Millennium Development Goals (MDGs). PoU is the central indicator in the most cited publication on global food insecurity development, the *State of Food Security and*

Nutrition in the World (SOFI). The SOFI is an annual report produced by the Rome-based UN agencies as well as UNICEF and WHO. The PoU reports the proportion of undernourished people in a population with undernourishment defined as a condition of continued inability to obtain enough food (FAO, 2021a).

Calculation of the PoU relies on the estimation of the availability of food, as well as the caloric requirements and intake distribution in the population. Supply of calories is used as a proxy to measure caloric consumption in the population and is derived from the National Food Balance Sheets reporting food availability for 179 countries and territories by source of supply for a range of food items, from domestic agricultural production as well as international trade, while also attempting to account for food waste (FAOSTAT, 2021). Differences in access to food in the population is calculated on the basis of nationally representative household surveys on income, expenditure, or consumption. For countries or years with no survey data, values are imputed or measured indirectly. The PoU corresponds to the probability that after randomly selecting an individual from the population, it will be under the energy consumption threshold for undernourishment called the Minimum Dietary Energy Requirement (FAO, IFAD, Unicef, WFP, and WHO, 2020). This nutritional threshold is set to the level of dietary energy considered necessary for an individual with a normal active and healthy life. The threshold for the entire population is the weighted average of the threshold of the different age or sex groups in the population (FAO, 2003). Demographic data on the projected and historical population structure by sex and age is extracted from the biannual World Populations Prospects. Information on the median height in each sex and age group is derived from the most recent Demographic and

Health Surveys or other surveys that collect demographic anthropometric data (FAO, et al., 2020). When the minimum dietary energy requirement, mean caloric consumption and coefficient of variation have been calculated, the PoU can be estimated.

The PoU has been the target of much criticism despite its status as a cornerstone of food security measurement. It does not measure undernourishment below two and a half percent and is thus not sensitive to low levels of undernourishment (UNSD, 2015c). It has been criticized for measuring a narrow, reductive, and insufficient concept of food insecurity characterized by a productivist understanding of food systems that centers national production, trade, and availability of calories (Fukuda-Parr and Orr, 2014; Lappé, et al., 2013; Pogge, 2016). Availability of food at the sub-national level is however generally not considered the decisive factor for determining undernutrition or famine (De Waal, 2017; Sen, 1981). Furthermore, the PoU is said to rely on problematic assumptions about the human body's ability to lower metabolism when experiencing low energy intake (Svedberg, 2001), assuming that the basal metabolic rate is the same across different regions (Hayter and Henry, 1994) and for over-estimating the variability of consumption (Svedberg, 2001). Since the PoU is designed for national and global measurements, it cannot be disaggregated to track differences between different groups at sub-national level (Fukuda-Parr and Orr, 2014).

On the other hand, FIES, SDG indicator 2.1.2, is a so-called experience-based food security indicator used to measure food security at the household and individual level. Experience-based food insecurity indicators attempt to capture behavioral and psychosocial indications of food insecurity from household surveys (Coates, Swindale, and Bilinsky, 2007). Parts of the methodology that FIES builds on was published early in the 90s in the USA following Reagan-era worries about the lack of data on hunger in the country (Radimer, Olson, and Campbell, 1990; Radimer, Olson, Greene, Campbell, and Habicht, 1992). Experience-based food insecurity measurement is thus older than FIES. Different experience-based food security indicators are in use around the world, mainly in the Americas. Each country has obtained its own scale and thresholds, but these are not directly comparable across countries. In 2017, FIES was for the first time included in the SOFI with measurements of numbers of *food secure or marginally insecure* or *severely food insecure* (FAO, IFAD, Unicef, WFP, and WHO, 2017). As of 2019, SOFI also included FIES measurements of *moderate or severe food insecurity* (FAO, et al., 2019). FAO provides technical support and works towards the inclusion of FIES in surveys and national censuses (FAO, 2016).

The indicator is available both in individual and household versions (FAO, 2020), but in the context of the SDGs it is used as an individual indicator. Data for FIES is collected using a survey that poses the eight *yes* or *no* questions in Table 1.

1	During the last 12 MONTHS, was there a time when you were worried you would not have enough food to eat because of a lack of money or other resources?
2	Still thinking about the last 12 MONTHS, was there a time when you were unable to eat healthy and nutritious food because of a lack of money or other resources?
3	Was there a time when you ate only a few kinds of foods because of a lack of money or other resources?
4	Was there a time when you had to skip a meal because there was not enough money or other resources to get food?
5	Still thinking about the last 12 MONTHS, was there a time when you ate less than you thought you should because of a lack of money or other resources?
6	Was there a time when your household ran out of food because of a lack of money or other resources?
7	Was there a time when you were hungry but did not eat because there was not enough money or other resources for food?
8	During the last 12 MONTHS, was there a time when you went without eating for a whole day because of a lack of money or other resources?

Table 1. FIES survey questionnaire

FIES is based upon the Rasch model, which in turn is derived from Item Response Theory (IRT). IRT refers to a group of statistical models originally developed for purposes of educational testing that attempt to explain the relationship between latent characteristics and attributes (e.g., food insecurity or educational ability) and their measurable manifestations. The Rasch-model is a one-parameter IRT-model. Its central feature is the construction of a linear, continuous, and unidimensional measurement scale that is invariant across individuals (Nord, 2014; Stemler and Naples, 2021). The manifestations of latent attributes are obtained from data that represent the responses given to a set of chosen questions (FAO, et al., 2019). FIES uses the number of affirmative responses to the survey questions (raw score) to measure the probability that each respondent is beyond a certain threshold of food security (Cafiero, Viviani, and Nord, 2018). The extent to which respondents' raw scores corresponds the survey questions' ranking of severity, can in turn be tested.

A prevalence rate of food insecurity can in principle be calculated for any specified threshold along the severity scale. FAO uses three categories, as defined by two global thresholds: *food secure or marginally insecure*, *moderately food insecure* and *severely food insecure*. The two thresholds are set to correspond to the severity levels of questions 5 and 8. By studying how many respondents report different experiences, one establishes the continuous one-dimensional scale of severity that ranks of each experience (Nord, 2014). Experiences reported by a larger number of interviewees are deemed less severe and vice versa. The frequency of positive responses thus determines the level of severity of each question. Differences in responses between countries will therefore yield different scales and thresholds for classifying food insecurity in different countries (FAO, 2021).

The objective of FAO when it launched the Voices of the Hungry Project in 2013 was to ensure comparable experience-based food security data across countries (FAO, 2016). The result was FIES, which aimed to be a new standard for measuring global and national food insecurity. Worldwide data collection for FIES was started by FAO in 2014 and done by the private company Gallup World Poll. Gallup is a worldwide survey conducted since 2006 (Cafiero, et al., 2018). The randomized samples are intended to represent the entire civilian, non-institutionalized adult population of the country. Gallup mainly uses telephone surveys in middle and high-income countries. In what Gallup refers to as the *developing world*, it uses face-to-face interviews with randomly sampled households. Exceptions include areas where the safety of the enumerators is threatened (Gallup, 2020).

The innovation of FIES is the calibration of national severity scales to a global reference scale, which functions as a common metric (FAO, 2016). According to FAO, the global reference scale enables cross-national comparability and global aggregation of measurements. In the 2019 edition of SOFI, FAO included FIES data from 153 countries or territories worldwide to establish the global severity scale (FAO, et al., 2019). Converting FIES-based measures obtained in a national scale into measures expressed on the global reference scale requires the identification of *anchor* points for which measures in the two scales are known. These points are questions to which responses from different national scales differ in severity by less than a specified margin (Cafiero, et al., 2018).

3.2 Establishing the Architecture for the SDG indicator process: The Critical Juncture

In this section, we describe the critical juncture that marked the transition from the preformation to the formation phase in the SDG 2.1 indicator selection process: The establishment of the institutional architecture for the indicator selection process. An important principle in the design of the SDGs was the division between the political negotiations of goals and targets, and the supposedly technical work of selecting indicators. The formulation of the goals and targets was intentionally set up as a process of political negotiations amongst states, while a group of statisticians from national statistical offices got the mandate to approve the indicator framework.

The Open Working Group (OWG) was given a mandate by the Rio+20 UN Conference on Sustainable Development to develop SDG goals, targets, and proposals for indicators. This structure was copied from the precursory MDGs. From the outset, quantitative indicators were thus the chosen method of monitoring progress, excluding qualitative methods of evaluation. The OWG was a political body consisting of representatives from member states and developing countries. The OWG concluded its work with a proposal to the UN General Assembly in September 2014, with suggestions for 17 goals and 169 targets (UNGA, 2014).

The formal process of establishing an indicator framework was initiated only after the OWG negotiations were completed. The OWG did however publish a series of consultative statistical notes mapping suitable indicators and their data requirements, including a note on food security and nutrition outlining potential SDG food security indicators and their data limitations (UNSD and FoC, 2014). The UN Statistical Commission, which is the highest body of the global statistical system facilitated a series of events and key reports in 2015 to prepare the grounds for the process for establishing an indicator framework. In February, an Expert Group Meeting on SDG indicators recommended the establishment of the IAEG-SDGs, a body with the authority to approve or reject indicators (Dodds, Donoghue, and Roesch, 2017).

The following month, the Statistical Commission held its 46th session (UNSC, 2015a). It was at this meeting that the Statistical Commission and its member states formally established the IAEG-SDGs, passing the responsibility from the OWG to the IAEG-SDGs. It stated that the "*development of a high quality and robust indicator framework is a technical process*" (UNSC, 2015a, p. 11). The IAEG-SDGs was intended to be a purely technical body. All 27 representatives in the IAEG-SDGs are statisticians from national statistical offices, each of them representing a group of member countries. These are supplemented by representatives from regional and UN organizations who have status as observers, but provide input and support (UNGA, 2017). NGOs, academia, and private business also contribute to the process, for instance through commenting upon specific indicators. The IAEG-SDGs have designated a custodian agency chosen among UN agencies and other relevant international organizations for each indicator. The United Nations Statistics Division (UNSD), mandated to coordinate and fulfill needs in the global statistical system, took on the role as secretariat to the IAEG-SDGs. At the same session, a technical report was presented by the Statistical Commission, containing 304 indicators proposed for the SDGs by experts in various UN and other international agencies, providing a starting point for the IAEG-SDGs (UNSC, 2015b). In addition, agencies were requested to provide for their proposed indicators the possible data source and the name of the potential custodian agency that would be responsible for global monitoring.

Custodian agencies are charged with the task of designing a data collection and reporting system in the SDG indicator framework. They also have the responsibility to support countries in data use and analysis, regional and global aggregation, harmonization of data, reporting to the Global SDG Database and developing statistical methodology. SDG indicators were in turn grouped into three tiers: Tier I (Indicator conceptually clear, established methodology and standards available and data regularly produced by countries), Tier II (Indicator conceptually clear, established methodology and standards available but data are not regularly produced by countries) and Tier III (Indicator for which there are no established standards or methodology/standards are being developed/tested) (Dodds, et al., 2017).

We interpret the formation of the IAEG-SDGs as a critical juncture in the development of a monitoring system for the SDGs, narrowing the decision space for the indicator framework of the SDGs. In the following sections, we argue that this specific institutional architecture limited the indicator alternatives available for serious consideration, due to the interplay between the IAEG-SDGs and its custodian agencies.

3.3 The SDG Target 2.1 Indicator Selection Process

The OWG background note on food security and nutrition discussed a wide range of indicators for consideration. These included indicators of undernourishment and energy deficiency, national food balance sheets, experience-based indicators, resilience indicators, composite indicators, indicators of malnutrition and indicators of dietary diversity and quality (UNSD and FoC, 2014). The indicator selection process however quickly revolved almost exclusively around the FAO-indicators PoU and FIES. The well-known global food security indicator PoU was adopted as a Tier I indicator already in the first meeting in the IAEG-SDGs (UNSD, 2015a). But while PoU was approved from the outset, FIES was met with considerable skepticism from national experts.

In the technical report for the 46th session of the Statistical Commission, each indicator proposal was ranked from A to C by experts from national statistical systems according to criteria of feasibility, suitability, and relevance. FIES received the lowest given rank C for feasibility, B for suitability and B for relevance. This meant that it was considered difficult to implement even with strong effort due to concerns with the methodology and data availability, and only somewhat relevant. The result for suitability indicated a widespread wish from the statisticians to "*discuss and/or consider*" other indicators of food security (UNSC, 2015b, p. 10).[11] As we will show in the coming sections, the decision space would however narrow with the formal initiation of the indicator process. PoU meanwhile received a B for feasibility, A for suitability and A for relevance.

This technical report provided the foundation for the proposed indicator list used in the first meeting of the IAEG-SDGs in June 2015. UNSD compiled the previous suggestions into a list of proposed indicators. In addition to previous details, agencies

[11] Rank A was given if 60 percent or more of statisticians chose A. C was given if 40 percent or mor of statisticians chose C. B was given if none of these criteria were fulfilled.

were also requested to provide metadata on the proposed indicators. In cases where multiple indicators were proposed under one target, precedence was in general given to the proposals made by potential custodian agencies with a mandate in the specific area or those already responsible for global monitoring of the specific indicator (UNSD, 2015a).

Following the poor ranking by national experts, FIES was omitted from the list of proposed indicators for the first meeting of the IAEG-SDGs (UNSD, 2015a). In its note on SDG 2 indicator metadata, FAO (2015:1) responded by insisting for FIES to be included in the indicator framework in a strongly worded remark. Here, they argued that FIES is an ideal indicator for the SDGs due to what it claims to be a universal design which makes it applicable to both developing and developed countries: "*Retaining the PoU while excluding the FIES undermines the effort to provide a more meaningful, comprehensive and timely metric for food access in the SDG era, essentially sticking to the already established MDG indicator. Furthermore, this choice undermines the universality ambition of the SDGs, by selecting an indicator that is primarily designed for developing countries (the PoU) rather than an indicator that is applicable to both developed and developing countries (the FIES).*" It is notable that the argument was grounded in the overall mission statement of the SDGs that it should be a break with the MDGs, in that indicators should apply both to developing and developed countries equally.

A formal proposal for the inclusion of FIES was made by the Rome-based agencies with its inclusion on a list of indicator proposals from custodian agencies in July 2015 (UNSD, 2015c). In the list, the same agencies suggested the inclusion of the food security indicator Food Consumption Score (FCS). The FCS is a household survey food security indicator developed by the UN World Food Programme, which is based on data on dietary diversity and food consumption frequency.

During an open consultation for members and observers in the run-up to the second meeting of the IAEG-SDGs, a group of UN chief statisticians, including representatives from FAO, suggested the demotion of the FCS to an *additional indicator*, as opposed to FIES and PoU-indicators which were categorized as *priority indicators* (UNSD, 2015e). During the consultation, a wide range of alternative indicators were proposed by a heterogenous group of actors but were quickly discarded as none of the additional suggestions were included in the list of indicator proposals for the second meeting of the IAEG-SDGs.

In the report from the July 15 meeting, almost fifty submitted remarks from NGOs, the private sector and academia emphasized the need for indicators for Target 2.1 that capture elements of food security such as dietary diversity, malnutrition, micronutrient deficiency, public welfare schemes, public financing, the presence of food security legislation, agricultural technology investment, crop yields, food safety, the impact of climate change, freshwater availability, resilience, sustainability, self-sufficiency, and breastfeeding (UNSD, 2015f). There were also repeated calls for disaggregation of SDG 2.1 indicators into groups of gender, ethnicity, age, and disability. Countries also suggested several indicators for Target 2.1 such as indicators of dietary diversity among women and national food balance sheets which eventually were left out (UNSD, 2015d). The same was the case for alternative proposals by the United Nations

Development Programme such as the composite macro-indicator Global Hunger Index. The IAEG-SDGs did not budge from its pathway.

Following its demotion, the FCS was also excluded from the list of proposed indicators crafted by the second meeting of the IAEG-SDGs in October 2015 (UNSD, 2015b). Despite low initial rankings, considerable skepticism, and wide range of alternative indicator suggestions, FIES was included along with PoU in the list. FIES was initially ranked as a Tier I indicator but was in November 2017 reclassified as a Tier II indicator following concerns with data availability (UNSD, 2017). After a data availability review in October 2019 claiming the availability of FIES for 136 out of 193 countries, FIES was again reclassified as a Tier I indicator (UNSD, 2019), fulfilling the indicator's journey to become an international standard for global food security monitoring.

The IAEG-SDG's approval of FIES in the October 2015 meeting marks the transition from the formation phase to the lock-in phase for the SDG Target 2.1 indicator selection. Despite the abundance of suggestions for food security indicators both during the preformation and formation phases, only the FAO-indicators PoU and FIES were given serious consideration as SDG indicators, with the FCS in practice quickly excluded by demotion to status as an 'additional indicator' in an indicator framework that does not operate with such categories. To explain why so few of the suggested indicators were thoroughly evaluated, we continue our analysis of path dependency in the SDG indicator process.

3.4 Forming the SDG Lock-in: Resource constraints and data availability

To examine the pathway to lock-in, we analyze the interplay between the IAEG-SDGs, FAO and other custodian agencies. The IAEG-SDGs faced a range of resource constraints that affected the development of the indicator framework. They had to work under intense time pressure, and while they were tasked with evaluating new indicators, they also had to evaluate indicators that were already part of the MDG legacy.

A member of the IAEG-SDGs highlighted the significant extent of dependency on the initial set of indicators proposed by UN and other international organizations, as well as the time constraint: "*For the IAEG one constraint was time and the other was that we were given a set of indicators that were proposed by international agencies. Some of those came from the MDGs, but most of them were new.*"[12] The time constraint had enhanced the position of the custodian agencies like FAO with already established indicators. Firstly, developing indicators from scratch was not viable with the short time allocated. Secondly, it left the IAEG-SDGs in a position where they could mainly react to proposals from UN and international organizations. In sum, it left potential custodian agencies in a powerful position.

Two members of the IAEG-SDGs specifically argued that the choice of indicators by custodian agencies was not based on technical grounds but rather driven by self-interest.[13] Another member argued that custodian agencies prompting the use of their own indicators should not necessarily be seen as negative. This is because it is

[12] Interview, country representative of the IAEG-SDGs 22 November 2018.
[13] Interview IAEG-SDGs 22 November 2018.
Interview, country representative of the IAEG-SDGs 5 February 2019.

recognized that they possess a competence in relevant policy-fields in which the IAEG-SDGs was lacking:

> "*When they are pushing for one of those indicators or several of those indicators, there is a program or work or a project or an idea that they want to push for their own sake. Which on the other hand does not mean that it is a bad thing. It may be good because that is the way the phenomena has to be addressed and there are public policies that they want to encourage. Of course, you may have agendas which are very personal because some director would like to have that project. So, it is very difficult to qualify those interests. But of course, I think there are interests in the agencies in proposing one or another indicator.*"[14]

A related constraint frequently brought up in the interviews is the structure of expertise in the IAEG-SDGs, which consists exclusively of members from national statistical offices, with UN, international and regional organizations participating as observers.[15] Statisticians, who may not be very familiar with measurement of sustainability or food security, found themselves charged with the responsibility of selecting indicators that could capture these new and complex ambitions (Elder and Olsen, 2019). A member of the IAEG-SDGs stated that a division of work between the body and custodian agencies is needed due to its constrained expertise.[16] Custodian agencies are particularly focused on indicators that are not part of the traditional portfolio of national statistical offices.[17] This statement made by a FAO food security statistician corroborates the central importance of custodian agencies as providers of expertise:

[14] Interview IAEG-SDGs 22 November 2018.
[15] Interview, country representative of the IAEG-SDGs 14 December 2018.
[16] Interview, country representative of the IAEG-SDGs 1 November 2018.
[17] Interview IAEG-SDGs 1 November 2018.

"*I think that the most difficult aspect is that the IAEG-SDGS as I said has been mandated with a very broad area of responsibility. Where they have failed sometime, is to mobilize the most appropriate resources from each field. […] So they have relied a lot on professionals or people working institutionally with the agencies.*"[18]

The interviews exemplify how the advantages of custodian agencies over the process of indicator selection has several features. Since the very beginning of the indicator selection process, custodian agencies have been drawn upon as crucial sources of expertise and resources. This is partly due to the agencies' respective areas of work and expertise frequently not being a part of the traditional portfolios of national statistical offices or covered by official statistics. Secondly and conflating this effect, potential custodian agencies initially proposed all the SDG indicators for the IAEG-SDGs' consideration. Thirdly, agencies like FAO that are well positioned to fulfill custodian responsibilities have received preferential treatment, as precedence was given to indicator proposals by agencies with a relevant mandate or already responsible for global monitoring. Custodian agencies have therefore had special leverage in the process of suggesting and selecting indicators.

This creates a potential conflict of interest for the custodian agencies within the IAEG-SDGs. The expertise of custodian agencies is needed under the current institutional architecture. However, custodian agencies are themselves producers of global indicators in their respective field of work and they will inevitably have an interest in promoting their use. The case of FAO's role in the SDG 2.1 indicator selection process

[18] Interview FAO food security statstician 10 May 2019

supports previous findings that producers of indicators actively seek an audience for their indicators (Barman, 2016; Merry, 2016). The potential benefits of promoting an indicator to be a part of global SDG monitoring are significant in terms of funding opportunities (Jerven, 2017), building reputation, greatly expanding the indicator's use and authority, as well as through having effects on other actors through impacting governance and knowledge (Merry, 2016). In the case of the SDGs, such governance and knowledge effects are global in their ramifications.

Due to its mandate, it was in principle possible for the IAEG-SDGs to fully revise the SDG indicator framework. A decision was however made to give the potential custodian agencies such as FAO advantages in suggesting indicators and formulating an initial indicator framework. Custodian agencies in turn used their resources and expertise to fill the space created by the time constraints of the IAEG-SDGs. Thus, what was framed as an open-ended process, soon became path dependent. The outcome was an indicator framework heavily impacted by custodian agencies' preferences and interests.

There are also pragmatic dimensions to this path dependency. Infrastructures of measurement, in the sense of the material and technological basis for data collection, selection and analysis, both enables and constrains what can be measured (Merry, 2019). Particularly costs affect how states and organizations gather and use statistics, as new indicators can require the expensive collection of new data and establishment of novel infrastructure (Jerven, 2017). The outcome is often data inertia, where old indicators are used to measure new problems (Merry, 2016).

This kind of data inertia is particularly pronounced in measuring global food security. With regards the Food Balance Sheets that the PoU depend on, FAO has (primarily through national authorities) been collecting data and standardizing procedures since the 1940s (FAO, 1949). The FIES was meanwhile created through a global data collection efforts in 2014, which was crucial input for the establishment of its global severity scale, enabling comparison of measurements from different countries. These data collection efforts have continued and been bolstered through the annual SOFI-reports. Both the PoU and FIES thus already had well-established global data infrastructures.

International organizations that have the capacity to establish and manage global data infrastructures are thus well-positioned to make their indicators relevant and attractive for the SDGs. As a UN agency, the FAO was in a particularly advantaged position in terms of leveraging its global data collection infrastructure. The alternative indicators have not been subject to worldwide long-term data collection, treatment, and standardization efforts.

4. The Knowledge Politics of Food Security Measurement

Food security measurement was arguably more vulnerable to path-dependency than other SDG targets like poverty and health. Measurements of food insecurity in the population is not commonly part of national official statistics, leaving the IAEG-SDGs with a gap that to a large extent was filled by FAO data and statistical expertise. In this way, rather than opening space for a more pluralistic approach, the IAEG-SDG process locked in the position of the dominant monitoring machinery for food security and hunger.

The contestation surrounding FIES provides an illustrative example of how food security quantification is characterized by ambiguity in concepts, classifications, and measurement. The difficulties of separating technical and political elements in indicator selection is amplified in the context of food security, distinguished by a lack of gold standards and benchmarks that can be employed to effectively challenge methods and measurements (Upton, et al., 2016). When no numbers can be exactly "right" or "wrong", neither in theory nor practice, it is hard to contest quantitative measurements on epistemic grounds.

FAO's mandate, expertise and sheer size enabled it to position its own indicators for uptake in the SDGs. Despite a wide range of alternative indicator suggestions, the ability to freely choose how to measure hunger and food security was quite limited due to the organization's position as the obvious custodian of most SDG2 indicators. The few alternatives available in terms of global macro indicators comparable to PoU for instance, tend to also depend heavily on FAO data (Concern Worldwide and Welthungerhilfe, 2020; Economist Intelligence Unit, 2020). The measurement of PoU in turn depends on living standard surveys, population data and self-published macro Food Balance Sheets. It thus requires levels of expertise and financial resources that are unavailable to smaller organizations. This shows how the inherent complexity in food security quantification favors input from dominant and resource-rich actors within the field, serving as a powerful example of how scientific pathways can be self-reinforcing by limiting the array of alternatives and allocating power to incumbents (Leach, et al., 2020).

The political implications of selecting food security indicators for the SDGs are however not limited to the context of specific international processes and organizations. Analysis of knowledge politics is needed to widen the narrow solution framing suggested by the SDG food security indicators, which have potential consequences for food security policy and practice. Such a broadening can in turn open the agenda for food system transformation.

FIES complements the PoU as an indicator for the SDGs due to its exclusive reliance on survey data and broader conception of food security. It can provide measurements of food insecurity in both poor and wealthy countries, that can be disaggregated to monitor vulnerable groups. The PoU due to its emphasis on calories and insensitivity to low measures remains mainly relevant in poor countries. It is built on top off a productivism that centers national availability of calories. The overall picture is, thus, that the SDG indicators frame food insecurity first and foremost as an issue of caloric supply and demand and individual experience, while the dimensions of democratic agency and environmental sustainability promoted by the HLPE-CFS (2020) remain elusive. It is therefore a risk that policies and programs with indirect and long-term effects on food security receive less attention than more direct and short-term interventions.

Opening the decision space to a more pluralistic set of interests and perspectives can facilitate quantification of food security that better represents its multidimensionality

(Leach et al. 2020). Alternative conceptualizations of food security exist in a wide range of discourses on food systems in academia, social movements, NGOs as well as international agencies like FAO. The agency and sustainability dimensions of food security are already increasingly influencing food security indicator discussions outside the SDG framework. The draft HLPE-CFS report (2022) on food security data collection and analysis for instance provides valuable insights into how indicators can give voice to the people most affected by food security policy.

Clapp et al. (2021) suggested the use of sustainability indicators such as soil health parameters, agrobiodiversity indicators, water quality or the use of sustainability certification, or more integrative indexes and frameworks. SDG indicator 2.4.1 attempt to measure the share of productive and sustainable agriculture incorporate and includes some of these measures. It however still lacks data and has been a heavily contested indicator (McNeill, 2019). An indicator suggested by Sterling et al. (2017) that could capture the resilience element of sustainability is asking households if they had a stable food supply the last year, and recording whether the food was subsistence-based, bought or sourced through exchange.

Agency at both the individual and collective level is important for food security outcomes (Clapp, Moseley, Burlingame, and Termine, 2021). The FIES survey module could be expanded to better capture individual agency in food security. It is however less suited to capture collective democratic participation at national or local levels, key in the approach advocated by actors in the food sovereignty movement (Agarwal, 2014; McMichael, 2014). Some indicators that can give us insights into collective levels of agency are measuring national commitments to uphold the right to food (te Lintelo, Haddad, Lakshman, and Gatellier, 2014), as well as levels of self-sufficiency, market concentration, prevalence of fair trade, and participation in member-based associations, cooperatives, or unions (Clapp, et al., 2021). There is not a plethora of suitable qualitative indicators. Monitoring the presence of food security legislation has however been suggested (UNSD, 2015f). The right to be free from hunger is for instance enshrined in the Indian constitution, which in principle makes its government legally accountable for national and individual food security (Banik, 2016).

The numerous suggestions for alternative indicators in the SDG process furthermore included indicators that may be suited to capture other elements of agency in food security and nutrition, such as emancipation for marginalized groups. The Women's Empowerment in Nutrition Index (Narayanan et al. 2022), Women's Empowerment in Livestock Index (Galiè, et al., 2019), and Women's Empowerment in Agriculture Index (IFPRI, 2012) are tailored to capture women's agency in agriculture, livestock management, and nutritional outcomes.

The alternatives generally lack the global data infrastructures and comparability of the SDG 2.1 indicators. Avoiding data inertia through more pluralistic measurement of global food security therefore requires alternative infrastructures that enable data gathering, treatment and standardization on an international scale. A handful of relevant initiatives are currently being undertaken (Countdown, 2022; Gallup, 2022; IMMANA, 2022). These however mainly emphasize nutrition rather than a broad concept of food security.

5. Conclusion

The technical and political aspects of the SDGs are deeply entangled, despite conscious efforts to separate them. Here we have shown that rather than opening space for a more pluralistic approach, the SDG2.1 indicator selection process was characterized by path dependency and locked in FAO's food security indicators from an early stage. Key enforcers of this path dependency were resource constraints and limited availability data: The chosen FAO indicators were among few options with well-established global data infrastructures.

The important SDG 2.1 thus arguably encapsulated a narrow understanding of food systems. The ultimate reason that we should care if certain indicators attain political or institutional advantages over others is that methods of measuring food security have real effects not only on the discourse surrounding food insecurity but also on how it is addressed in policy and practice. Further investments in alternative data infrastructures are needed to adequately capture the multidimensionality of food security through statistics.

Literature

Agarwal, Bina. 2014. "Food sovereignty, food security and democratic choice: Critical contradictions, difficult conciliations." *Journal of Peasant Studies, 41*, 1247-1268.

Banik, Dan. 2016. "The hungry nation: Food policy and food politics in India." *Food ethics*, *1*(1), 29-45.

Barman, Emily. 2016. *Caring Capitalism*. New York: Cambridge University Press.

Barrett, Christopher B. 2010. "Measuring Food Insecurity." *Science, 327*, 825-828.

Berry, Sara S. 1984. "The Food Crisis and Agrarian Change in Africa: A Review Essay." *African Studies Review, 27*, 59-112.

Cafiero, Carlo, Juan Feng, and Adeeba Ishaw. 2020. Methodological note on new estimates of the Prevalence of Undernourishment in China. In *FAO Statistics Working Paper Series*. Rome: Food and Agricultural Organization.

Cafiero, Carlo, Viviani, Sara, and Nord, Mark. 2018. "Food security measurement in a global context: The food insecurity experience scale." *Measurement, 116*, 146-152.

Clapp, Jennifer, William G. Moseley, Barbara Burlingame, and Paola Termine. 2021. "Viewpoint: The case for a six-dimensional food security framework." *Food policy, 106*, 102164.

Coates, Jennifer, Anne S. Swindale, and Paula Bilinsky. 2007. Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide. Washington DC: USAID.

Concern Worldwide, and Welthungerhilfe. 2020. 2020 Global Hunger Index: One Decade to Zero Hunger - Linking Health and Sustainable Food Systems.

Countdown. 2022. *Countdown to 2030*. https://www.countdown2030.org/about

David, Paul A. (1985). "Clio and the Economics of QWERTY." *The American economic review, 75*, 332-337.

De Waal, Alex. (2017). *Mass starvation: The history and future of famine*. New Jersey: John Wiley & Sons.

Dodds, Felix, David Donoghue, and Jimena L. Roesch. 2017. *Negotiating the Sustainable Development Goals - A Transformational Agenda for an Insecure World*. London: Routledge.

Economist Intelligence Unit. 2020. Global Food Security Index 2019. London: Economist Intelligence Unit.

Elder, Mark Elder, and Simon Høiberg Olsen. 2019. "The Design of Environmental Priorities in the SDGs." *Global Policy, 10*, 70-82.

FAO. 1949. *Food Balance Sheets*. Rome: Food and Agricultural Organization.

FAO. 2003. Proceedings: Measurement and Assessment of Food Deprivation and Undernutrition: International Scientific Symposium. Rome: Food and Agricultural Organization.

FAO. 2013. New approaches to the measurement of food security. Rome: Food and Agricultural Organization.

FAO. 2015. FAO Goal 2 Metadata. In Rome: Food and Agricultural Organization.

FAO. 2016. Voices of the Hungry - Technical Report. Rome: Food and Agricultural Organization.

FAO. 2017. The Food Insecurity Experience Scale: Measuring food insecurity through people's experience. Rome: Food and Agricultural Organization.

FAO. 2020. Voices of the Hungry - Frequently Asked Questions. Rome: Food and Agriculture Organization.

FAO. 2021. Voices of the Hungry - Frequently Asked Questions. Rome: Food and Agricultural Organization.

FAO, IFAD, Unicef, WFP, and WHO. 2017. The State of Food Security and Nutrition in the World. In: Food and Agriculture Organization, International Fund for Agricultural Development, Unicef, World Food Programme and World Health Organization.

FAO, IFAD, Unicef, WFP, and WHO. 2019. The State of Food Security and Nutrition in the World. In: Food and Agriculture Organization, International Fund for Agricultural Development, Unicef, World Food Programme and World Health Organization.

FAO, IFAD, Unicef, WFP, and WHO. 2020. Food Security and Nutrition in the World: Transforming Food Systems for Affordable Healthy Diets. In: Food and Agriculture Organization, International Fund for Agricultural Development, Unicef, World Food Programme and World Health Organization.

FAO, IFAD, Unicef, WFP, and WHO. 2021. The State of Food Security and Nutrition in the World. In: Food and Agriculture Organization, International Fund for Agricultural Development, Unicef, World Food Programme and World Health Organization.

FAOSTAT. 2021. New Food Balances. Rome: Food and Agricultural Orgnization.

FAOSTAT. 2022. Food and agriculture data. Rome: Food and Agricultural Organization.

Fukuda-Parr, Sakiko, and Desmond McNeill. 2019. "Knowledge and Politics in Setting and Measuring the SDGs: Introduction to Special Issue." *Global Policy, 10*, 5-15.

Fukuda-Parr, Sakiko, and Amy Orr. 2014. "The MDG hunger target and the competing frameworks of food security." *Journal of Human Development and Capabilities, 15*, 147-160.

Galiè, Alessandra. et al. 2019 "The women's empowerment in livestock index." *Social Indicators Research, 142*, 799-825.

Gallup. 2020. How Does the Gallup World Poll Work? Washington D.C.: Gallup Inc.

Gallup. 2022. Global Diet Quality Project Aims to Bridge Data Gap. Washington D.C.: Gallup Inc.

Hayter, June E., and Christiani Jeyakumar Henry. 1994. "A re-examination of basal metabolic rate predictive equations: the importance of geographic origin of subjects in sample selection." *European Journal of Clinical Nutrition, 48*, 702-707.

Hill, Polly. 1984. "The poor quality of official socio-economic statistics relating to the rural tropical world: with special reference to south India." *Modern Asian Studies, 18*, 491-514.

HLPE-CFS. 2020. Food Security and Nutrition: Building a Global Narrative Towards 2030. In *HLPE Report 15*. Rome: High Level Panel of Experts on Food Security and Nutrition and the Comittee on World Food Security.

HLPE-CFS. 2022. *Data collection and analysis tools for food security and nutrition - Towards enhancing effective inclusive evidence-informed decision making*. In Rome: High Level Panel of Experts on Food Security and Nutrition and the Comittee on World Food Security.

IFPRI. 2012. Women's Empowerement in Agriculture Index. International Food Policy Research Institute: Washington DC.

IMMANA. 2022. *Welcome to IMMANA (Innovative Methods and Metrics for Agriculture and Nutrition Actions)*. Agriculture, Nutition and Health Academy.

Jerven, Morten. 2017. "How much will a data revolution in development cost?" *Forum for Development Studies, 44*, 31-50.

Jones, Andrew D., Francis M. Ngure, Gretel Pelto, and Sera L. Young. 2013. "What are we assessing when we measure food security? A compendium and review of current metrics." *Advanced Nutrition* 4:481-505.

Lappé, Francis M., Jennifer Clapp, Molly Anderson, Robin Broad, Ellen Messer, Thomas Pogge and Timothy Wise. 2013. "How we count hunger matters." *Ethics & International Affairs, 27*, 251-259.

Leach, Melissa, Nicholas Nisbett, Lídia Cabral, Jody Harris, Naomi Hossain, and John Thompson. 2020. "Food politics and development." *World Development 134*, 105024.

Maxwell, Daniel, Bapu Vaitla, and Jennifer Coates. 2014. "How do indicators of household food insecurity measure up? An empirical comparison from Ethiopia." *Food policy, 47*, 107-116.

McMichael, Philip. 2014. "Historicizing food sovereignty. " *Journal of Peasant Studies, 41*, 933-957.

McNeill, Desmond. 2019. "The Contested Discourse of Sustainable Agriculture." *Global Policy, 10*, 16-27.

Merry, Sally Engle. 2016. *The seductions of Quantification - Measuring Human Rights, Gender Violence, and Sex Trafficking*. Chicago: The University of Chicago Press.

Merry, Sally Engle. 2019. "The Sustainable Development Goals Confront the Infrastructure of Measurement." *Global Policy*, *10*, 146-148.

Narayanan, Sudha, Erin Lentz, Marzia Fontana, and Bharati Kulkarni. 2022. "Rural Women's Empowerment in Nutrition: A Framework Linking Food, Health and Institutions." *The Journal of Development Studies, 58*, 1-18.

Nature Plants. 2019. "Quis custodiet FAO?" *Nature Plants, 5*, 331-331.

Nord, Mark. (2014). Introduction to item response theory applied to food security measurement. Rome: Food and Agricultural Organization.

Pogge, Thomas. 2016. "The hunger games." *Food ethics, 1*, 9-27.

Radimer, Kathy L., Christine M. Olson, and Cathy Campbell. 1990. "Development of indicators to assess hunger." *The Journal of nutrition, 120*, 1544-1548.

Radimer, Kathy L., Christine M. Olson, Jennifer C. Greene, Cathy C. Campbell, and Jean-Pierre Habicht,. 1992. "Understanding hunger and developing indicators to assess it in women and children." *Journal of Nutrition Education, 24*, 36S-44S.

Ryan, Gery W., and Bernard, H. Russel. 2003. "Techniques to identify themes." *Field methods*, *15*(1), 85-109.

Sen, Amartya K. 1981. *Poverty and Famines - An Essay on Entitlement and Deprivation*. Oxford: Oxford University Press.

Stemler, Steven E., and Adam Naples. 2021. "Rasch Measurement v. Item Response Theory: Knowing When to cross the Line." *Practical Assessment, Research and Evaluation, 26 (2021)*, 1-16.

Sterling, Eleanor. J. et al. 2017. "Biocultural approaches to well-being and sustainability indicators across scales." *Nature ecology & evolution, 1*, 1798-1806.

Sukhatme, Pandurang Vasuedo. 1961. "The world's hunger and future needs in food supplies." *Journal of the Royal Statistical Society: Series A (General)* 124 (4): 463-508.

Sumberg, James. 2017. *Agronomy for development: The politics of knowledge in agricultural research*: Taylor & Francis.

Sumberg, James, and John Thompson. 2012. *Contested agronomy: Agricultural research in a changing world*: Routledge.

Sumberg, James, John Thompson, and Philip Woodhouse. 2012. *Contested agronomy: Agricultural research in a changing world*. In: *Contested agronomy: Agricultural research in a changing world*, edited by James Sumberg and John Thompson, 1-21. New York: Routledge.

Svedberg, Peter. 2001. Undernutrition Overestimated. In *Seminar Paper No. 693.* Stockholm: Institute for International Economic Studies, Stockholm University.

Sydow, Jörg, Georg Schreyögg, and Jochen Koch. 2009. "Organizational path dependence: Opening the black box." *Academy of management review, 34*, 689-709.

Tavory, Iddo. 2020. "Interviews and Inference: Making Sense of Interview Data in Qualitative Research." *Qualitative Sociology, 43*, 449-465.

Taylor, Marcus, Remy Bargout, and Suhas Bhasme. 2021. "Situating Political Agronomy: The Knowledge Politics of Hybrid Rice in India and Uganda." *Development and Change* 52 (1):168-191.

te Lintelo, Dolf J.H., Lawrence J. Haddad, Rajith Lakshman, and Karine Gatellier. 2014. The Hunger and Nutrition Commitment Index (HANCI 2013): Measuring the Political Commitment to Reduce Hunger and Undernutrition in Developing Countries. Brighton: Institute of Development Studies, University of Sussex.

UNGA. 2014. Report of the Open Working Group on Sustainable Development Goals established pursuant to General Assembly resolution 66/288. New York: United Nations General Assembly.

UNGA. 2017. Terms of reference for the Inter-Agency and Expert Group on Sustainable Development Goal Indicators. New York: United Nations General Assembly.

UNSC. 2015a. Report on the forty-sixth session. New York: United Nations Statistical Commission.

UNSC. 2015b. Technical report by the Bureau of the United Nations Statistical Commission (UNSC) on the process of the development of an indicator framework for the goals and targets of the post-2015 development agenda. New York: United Nations Statistical Commission.

UNSC. 2021. Tier Classification for Global SDG Indicators as of 29 March 2021. New York: United Nations Statistical Commission.

UNSD. 2015a. Proposed Priority Indicator List. New York: United Nations Statistics Division.

UNSD. 2015b. Results of the list of indicators reviewed at the second IAEG-SDG meeting. New York: United Nations Statistics Division.

UNSD. 2015c. List of proposals July 7 2015. New York: United Nations Statistics Division.

UNSD. 2015d. Summary of Comments on Indicator Proposals 30.09.15. New York: United Nations Statistics Division.

UNSD. 2015e. Open consultation for members and observers (As of 15 September 2015). New York: United Nations Statistics Division.

UNSD. 2015f. Open consultation: Detailed inputs from civil society, academia and private sectors. New York: United Nations Statistics Division.

UNSD. 2017. Sixth Meeting of the Inter-Agency and Expert Group on the Sustainable Development Goal Indicators - Report. New York: United Nations Statistics Division.

UNSD. 2019. Tier Classification of SDG Indicators 11 December 2019. New York: United Nations Statistics Division.

UNSD. 2021. Tier Classification for Global SDG Indicators. New York: United Nations Statistics Division.

UNSD and FoC. 2014. Statistical note 3: Food Security and Nutrition. United Nations Statistics Division and Friends of the Chair Group on broader measures of progress.

Upton, Joanna B., Jennifer D. Cissé, and Christopher B. Barrett. 2016. "Food security as resilience: Reconciling definition and measurement." *Agricultural economics, 47*, 135-147.

Völker, Thomas, Kirsty Blackstock, Zora Kovacic, Jan Sindt, J., Roger Strand, and Kerry Waylen. 2019. "The role of metrics in the governance of the water-energy-food nexus within the European Commission." *Journal of Rural Studies, 92,* 473-481.

Wanner, Nathan, Carlo Cafiero, Nathalie Troubat, and Piero Conforti. 2014. Refinements to the FAO methodology for estimating the Prevalence of Undernourishment indicator. In *ESS Working Paper No. 14-05, September 2014*. Rome: Food and Agricultural Organization.

Westengen, Ola, and Dan Banik. 2016. "The State of Food Security: From Availability, Access and Rights to Food Systems Approaches." *Forum for Development Studies, 43* (1), 113-134.

WFS. 1996. Rome Declaration on World Food Security and World Food Summit Plan of Action. Rome: World Food Summit and Food and Agricultural Organization.

Supplementary material

Documents reviewed for Article 1

Author	Year	Document
Gallup	2020	How Does the Gallup World Poll Work?’
Concern Worldwide, & Welthungerhilfe	2020	2020 Global Hunger Index: One Decade to Zero Hunger - Linking Health and Sustainable Food Systems. Global Hunger Index.
Economist Intelligence Unit (2020)	2020	Global Food Security Index 2019. Intelligence Unit.
CFS	2010	Thirty-sixth Session - Final Report. World Food Security.
CFS	2011a	CFS Rountable on Monitoring Food Security. In Tecnical Background Paper. Rome: Commitee on World Food Security.
CFS	2011b	Outcome of "Roundtable to review methods used to estiamte the number of hungry" (FAO, 12-13 September 2011. In. Rome: Commitee on World Food Security
CFS	2011c	Thirty-seventh Session - Final Report. In. Rome: Committee on World Food Security.
HLPE-CFS	2020	Food Security and Nutrition: Building a Global Narrative Towards 2030. In HLPE Report 15. Rome: High Level Panel of Experts on Food Security and Nutrition and the Comittee on World Food Security.
HLPE-CFS	2021	Data collection and analysis tools for food security and nutrition - Online consultation on the V0 Draft of the Report proposed by the HLPE Steering Committee and the Project Team. In. Rome: High Level Panel of

		Experts on Food Security and Nutrition and the Comittee on World Food Security.
HLPE-CFS	2022	Data collection and analysis tools for food security and nutrition - Towards enhancing effective inclusive evidence-informed decision making. In. Rome: High Level Panel of Experts on Food Security and Nutrition and the Comittee on World Food Security
FAO (Sukhatme)	1961	The world's hunger and future needs in food supplies. Journal of the Royal Statistical Society: Series A (General), 124, 463-508.
FAO	2003	Proceedings: Measurement and Assessment of Food Deprivation and Undernutrition: International Scientific Symposium
FAO	2013	New approaches to the measurement of food security.
FAO	2014	Revision of the methodology for the estimation of the Prevalence of Undernourishment.
FAO (Nord, M.)	2014	Introduction to item response theory applied to food security measurement.
FAO (Wanner, N., Cafiero, C., Troubat, N., & Conforti, P.)	2014	Refinements to the FAO methodology for estimating the Prevalence of Undernourishment indicator.
FAO (Graham, E., Miller, M., & Viviani, S.)	2014	Piloting Food Security Experience Scale in Africa, south of Sahara: Assessing food insecurity severity to support policy solutions. In Nature & Faun Volume 28 Issue 2: Food and Agricultura
FAO	2015	FAO Goal 2 Metadata.
FAO	2016	Voices of the Hungry - Technical Report.
FAO	2017	The Food Insecurity Experience Scale: Measuring food insecurity through people's experience.
FAO	2020	Voices of the Hungry - Frequently asked questions.

FAO (Cafiero, C., Feng, J., & Ishaw, A.)	2020	Methodological Note on New estimates of the Prevalence of Undernourishment in China. FAO Statistics Working Paper Series.
FAO	2021	Food security methodology. Rome: Food and Agricultural Organization.
FAO	2011	Global food losses and food waste. In. Rome: Food and Agricultural Organization.
FAO	2012	Proceedings - International Scientific Symposium on Food and Nutrition Security Information: From Valid Measurement to Effective Decision Making. In. Rome: Food and Agriculture Organization.
FAO	2019	State of Food and Agriculture - Moving forward of food loss and waste reduction. In. Rome: Food and Agriculture Organization.
FAO	1949	Food Balance Sheets - A Handbook
FAO	2008	Food Balance Sheets - A Handbook
FAOSTAT	2021	New Food Balances.
FAO	1946	Word Food Survey
FAO	1952	Second World Food Survery
FAO	1963	Third World Food Survey
FAO	1974	State of Food and Agriculture
FAO	1977	Fourth World Food Survey
FAO	1987	Fifth World Food Survey
FAO	1996	Sixth World Food Survey
FAO et al	1999	The State of Food Security and Nutrition in the World.
FAO et al	2000	The State of Food Security and Nutrition in the World.
FAO et al	2002	The State of Food Security and Nutrition in the World.
FAO et al	2003	The State of Food Security and Nutrition in the World.
FAO et al	2004	The State of Food Security and Nutrition in the World.
FAO et al	2006	The State of Food Security and Nutrition in the World.

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FAO et al	2013	The State of Food Security and Nutrition in the World.
FAO et al	2014	The State of Food Security and Nutrition in the World.
FAO et al	2015	The State of Food Security and Nutrition in the World.
FAO et al	2016	The State of Food Security and Nutrition in the World.
FAO et al	2017	The State of Food Security and Nutrition in the World.
FAO et al	2019	The State of Food Security and Nutrition in the World.
FAO et al	2020	The State of Food Security and Nutrition in the World.
FAO et al	2021	The State of Food Security and Nutrition in the World.
FAO	1950	Calorie requirements
FAO	1957	Second Committee on Calorie Requirements Report
FAO and WHO	1971	Energy and protein requirements
FAO	1985	Energy and protein requirements
FAO, WHO and UNU	2001	Human energy requirements

Documents reviewed for Article 2 and 3

Author	**Year**	**Document**
Concern Worldwide, & Welthungerhilfe	2020	Global Hunger Index: One Decade to Zero Hunger - Linking Health and Sustainable Food Systems. Global Hunger Index.
Economist Intelligence Unit	2020	Global Food Security Index 2019. London: Economist Intelligence Unit.
FAO (Sukhatme)	1961	The world's hunger and future needs in food supplies. Journal of the Royal Statistical Society: Series A (General), 124, 463-508.
FAO	1999	State of Food Insecurity in the World.' Rome: United Nations Food and Agricultural Organization.
FAO	2003	Proceedings: Measurement and Assessment of Food Deprivation and Undernutrition: International Scientific Symposium
FAO	2013	New approaches to the measurement of food security.
FAO	2014	Revision of the methodology for the estimation of the Prevalence of Undernourishment.
FAO (Nord, M.)	2014	Introduction to item response theory applied to food security measurement.
FAO (Wanner, N., Cafiero, C., Troubat, N., & Conforti, P.)	2014	Refinements to the FAO methodology for estimating the Prevalence of Undernourishment indicator.
FAO (Graham, E., Miller, M., & Viviani, S.)	2014	Piloting Food Security Experience Scale in Africa, south of Sahara: Assessing food insecurity severity to support policy solutions. In *Nature & Faun Volume 28 Issue 2*: Food and Agricultura
FAO	2015	FAO Goal 2 Metadata.
FAO	2016	Voices of the Hungry - Technical Report.

FAO	2017	The Food Insecurity Experience Scale: Measuring food insecurity through people's experience.
FAO	2020	Voices of the Hungry - Frequently asked questions.
FAO (Cafiero, C., Feng, J., & Ishaw, A.)	2020	Methodological Note on New estimates of the Prevalence of Undernourishment in China. *FAO Statistics Working Paper Series.*
FAO	2021	Food security methodology. Rome: Food and Agricultural Organization.
FAO et al	2017	The State of Food Security and Nutrition in the World.
FAO et al	2019	The State of Food Security and Nutrition in the World.
FAO et al	2020	The State of Food Security and Nutrition in the World.
FAO et al	2021	The State of Food Security and Nutrition in the World.
FAOSTAT	2021	New Food Balances.
Gallup.	2020	How Does the Gallup World Poll Work?' Washington D.C.: Gallup Inc.
HLPE-CFS	2020	Food Security and Nutrition: Building a Global Narrative Towards 2030. HLPE Report 15. Rome: High Level Panel of Experts on Food Security and Nutrition and the Comittee on World Food Security.
HLPE-CFS	2021	Data collection and analysis tools for food security and nutrition - V0 Draft for e-consultation December 2021
UNGA	2014	Report of the Open Working Group on Sustainable Development Goals established pursuant to General Assembly resolution 66/288.
UNSC	2015	Terms of reference for the Inter-Agency and Expert Group on Sustainable Development Goal Indicators.
UNSC	2015	Technical report by the Bureau of the United Nations Statistical Commission (UNSC) on the process of the development of an indicator framework for the goals and targets of the post-2015 development agenda.

UNSC	2021	Tier Classification for Global SDG Indicators as of 29 March 2021.
UNSD	2015	Proposed Priority Indicator List.
UNSD	2015	Results of the list of indicators reviewed at the second IAEG-SDG meeting.
UNSD	2015	List of proposals July 7 2015.
UNSD	2015	Summary of Comments on Indicator Proposals 30.09.15.
UNSD	2015	Open consultation for members and observers (As of 15 September 2015).
UNSD	2015	Open consultation: Detailed inputs from civil society, academia and private sectors.
UNSD	2015	Metadata Compilation for SDG Indicators 23 October 2015 Update
UNSD	2015	Agenda Item 4 - Review of proposed indicators
UNSD	2016	Provisional Proposed Tiers for SDG Indicators
UNSD	2016	Third IAEG-SDGs Meeting Report
UNSD	2017	Meeting Report 4th IAEG-SDGs Meeting
UNSD	2017	Meeting Report 5th IAEG-SDGs Meeting
UNSD	2017	Meeting Report 6th IAEG-SDG meeting
UNSD	2018	Meeting Report 7th IAEG Meeting
UNSD	2018	Meeting Report 8th IAEG Meeting
UNSD	2019	Tier Classification of SDG Indicators 11 December 2019. New York: United Nations Statistics Division.
UNSD	2019	Tier Reclassification - Data Availability
UNSD	2019	9th IAEG-SDG Meeting Report
UNSD	2020	10th IAEG-SDG Meeting Report 14.02.2020
UNSD	2020	11th IAEG-SDG Meeting Report
UNSD	2020	Tier Classification of SDG Indicators 17 July 2020

UNSD	2021	12th meeting of IAEG-SDGs - Q&A and other information
UNSD	2021	Outcomes of UN World Data Forum
UNSD	2021	Tier Classification for Global SDG Indicators. In. New York: United Nations Statistics Division.
UNSD and FoC	2014	Statistical note 3: Food Security and Nutrition. In: United Nations Statistics Division and Friends of the Chair Group on broader measures of progress.

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