



# ASSESSING THE IMPACT OF WAR IN YEMEN

*on Achieving the Sustainable Development Goals*

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# DISCLAIMER




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# PREFACE

This report is the second in a series exploring the impact of the war on Yemen's development. The report builds upon previous research, sponsored by the United Nations Development Programme (UNDP), exploring the impact of armed conflict on Yemen's development. The first report, "*Assessing the impact of war on development in Yemen*", established a methodological framework to understand the impact of conflict on development in Yemen.

Now in its fifth year, the conflict is characterized by a disproportionately high magnitude of suffering and indirect deaths due to the war's impacts on access to food, health services, and physical and social infrastructure. The protracted conflict has not only interrupted development in Yemen, it has reversed the country's hard-won development gains by 21 years.

This report is intended to inform all stakeholders working on Yemen of the alternative development pathway Yemen could have gone through if the war had not occurred. It drills several levels deeper to examine how the conflict is changing development across four SDGs, and explores alternative scenarios reflecting conflict and development pathways. The authors evaluate the impact of conflict in Yemen across four SDGs: *No Poverty* (SDG 1); *Zero Hunger* (SDG 2); *Decent Work and Economic Growth* (SDG 8); and, *Reduced Inequalities* (SDG 10). These SDGs were selected because they reflect core UNDP development priorities. The second part this report explores

alternative scenarios to understand pathways of development in the midst of ongoing conflict in Yemen. These scenarios include an increase in household consumption, improvement in the availability and distribution of food, improvement in access to safe water and sanitation, and the direct targeting of child malnutrition. In addition to these scenarios the report also explores the developmental impacts of ending the conflict in 2019.

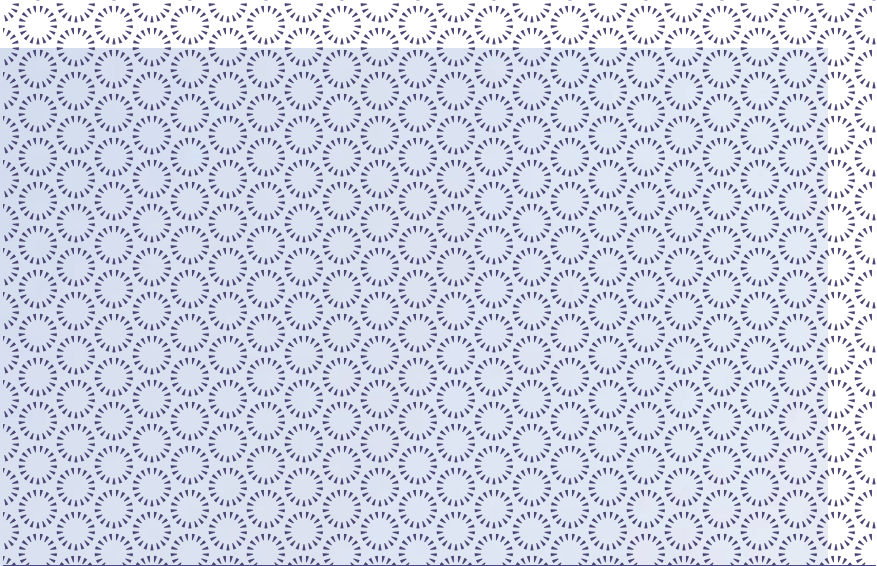
The International Futures modeling system is an open-source tool that provides a platform for understanding how development changes across time and issue-area. In the context of Yemen, this tool can provide policy-makers with the ability to see the broader consequences of their decisions, assessing the development trajectory be if the war ends in 2019, 2022, or 2030. The scenarios' projected results provide an invaluable tool at setting alternatives to the war and preparing for the unique recovery process that Yemen will require when all this over.

We hope that the findings of this report will shed light on the opportunity cost of the on-going war in Yemen and that it will sway the parties to the conflict and the international community that a political settlement to the war in Yemen is the best alternative for the country, before it slips to the point of no return. Given the incurred set back in development, we owe the promise of 'leaving no one behind' to Yemen.

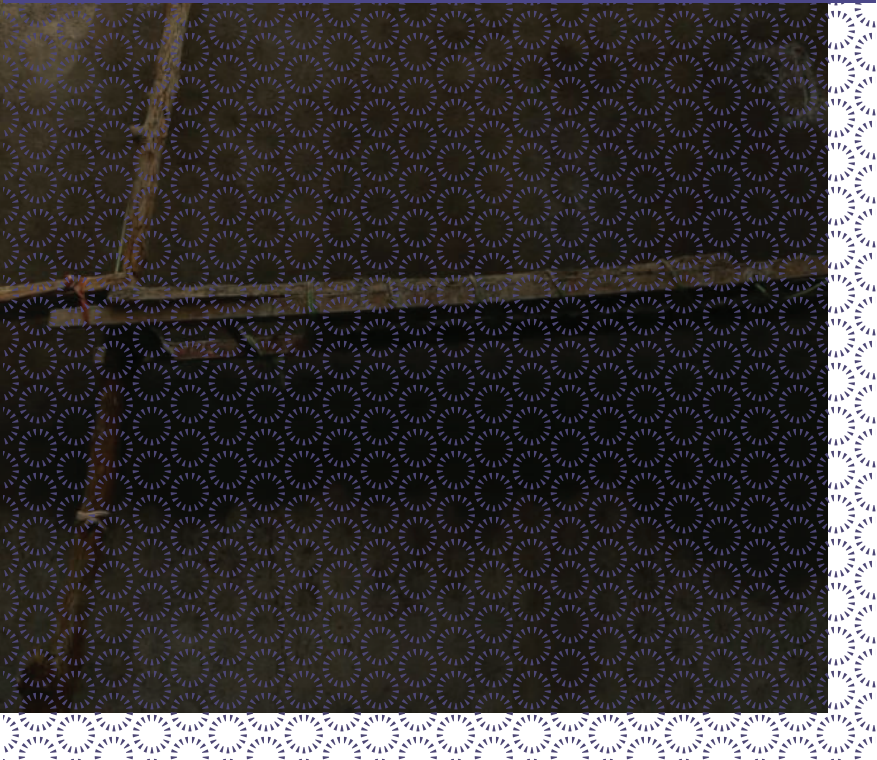
# LIST OF ABBREVIATIONS

<b>ACLED</b>	Armed Conflict Location and Event Data Project
<b>FAO</b>	Food and Agriculture Organization
<b>GDI</b>	Gender Development Index
<b>GDP</b>	Gross Domestic Product
<b>GTAP</b>	Global Trade Analysis Project
<b>IFs</b>	International Futures
<b>ILO</b>	International Labour Organization
<b>IMF</b>	International Monetary Fund
<b>MENA</b>	Middle East and North Africa
<b>MER</b>	Market Exchange Rates
<b>PPP</b>	Purchasing Power Parity
<b>R&amp;D</b>	Research and Development
<b>SAM</b>	Severe Acute Malnutrition
<b>SDG(s)</b>	Sustainable Development Goal(s)
<b>STEM</b>	Science, Technology, Engineering and Mathematics
<b>UN</b>	United Nations
<b>UNDP</b>	United Nations Development Programme
<b>USD</b>	United States Dollar
<b>WDI</b>	World Development Indicators
<b>YER</b>	Yemeni Rial





# EXECUTIVE SUMMARY



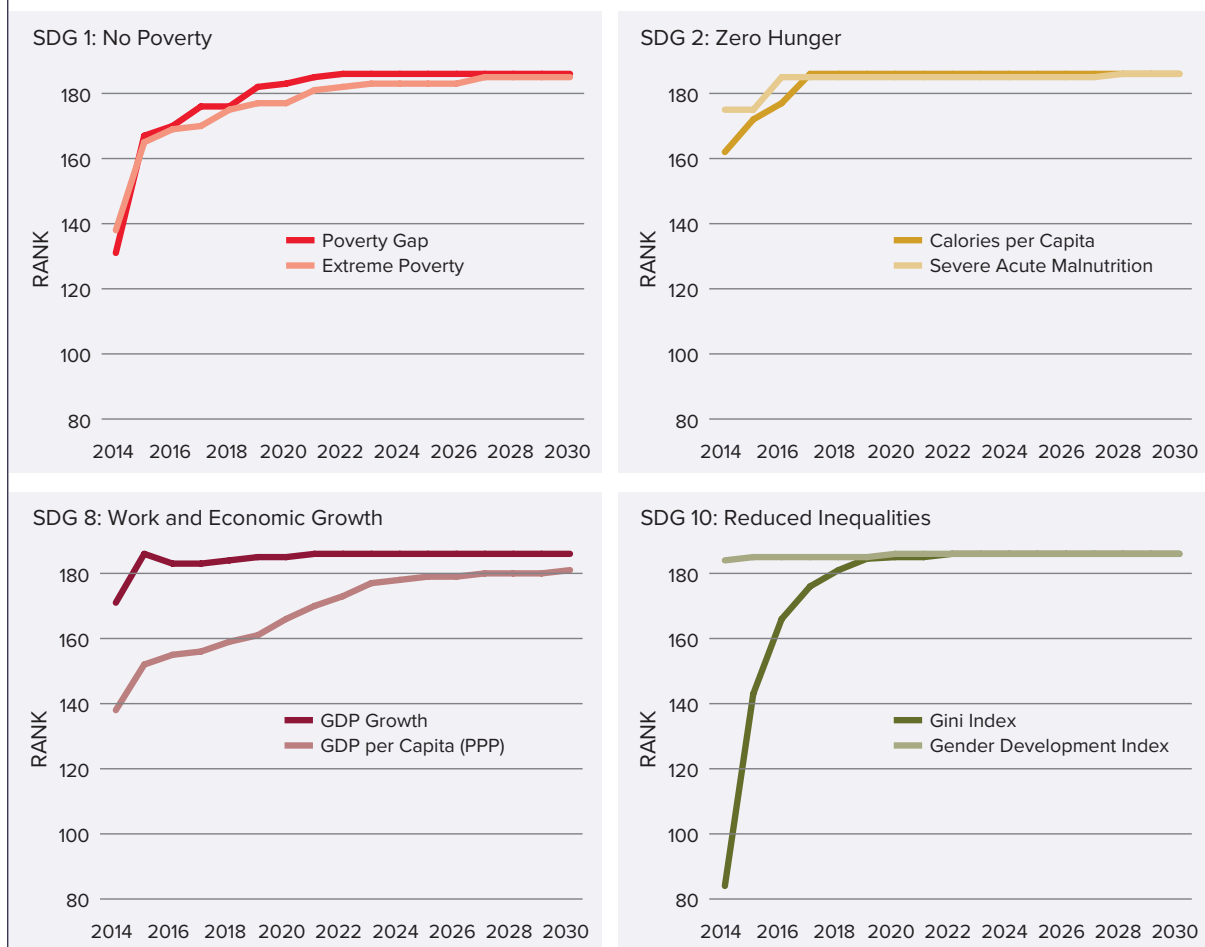


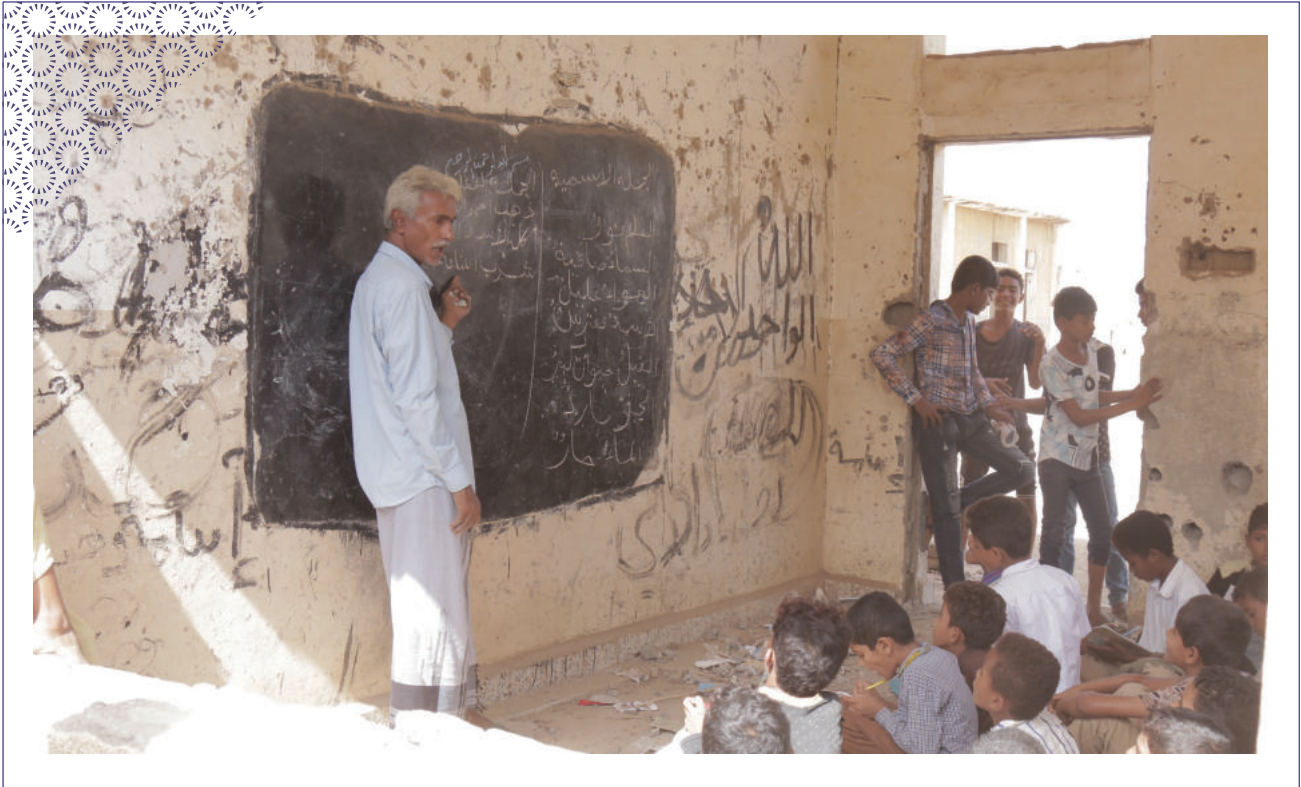
War in Yemen has already set back development by more than two decades, magnifying existing development challenges, creating new obstacles, and altering the country's future trajectory dramatically. This report expands upon previous research<sup>1</sup> by first analyzing how the conflict is changing development across four Sustainable Development Goals (SDGs). The four SDGs were chosen based upon core United Nations Development Programme (UNDP) priorities and are: *SDG 1: No Poverty*; *SDG 2: Zero Hunger*; *SDG 8: Decent Work and Economic Growth*; and, *SDG 10: Reduced Inequalities*. This, and previous work, was sponsored by UNDP.

If conflict persists past 2019, Yemen will have the greatest depth of poverty, second poorest imbalance in gender development, lowest calories per capita, second greatest reduction in economic activity relative

to 2014, and second poorest income inequality of any country in the world. Figure 1 shows Yemen's rank out of 186 countries across four SDG categories should conflict persist through 2030.

**FIGURE 1 | Yemen's global ranking across eight development indicators associated with four SDGs in a scenario of continued conflict in Yemen. The higher the number, the lower the standing.**





In addition, this report explores the impact of conflict on development in Yemen by creating alternative scenarios. These can be used to measure the *conflict-attributable* impact of war on development. Two alternative scenarios are used to measure this impact:

- ▶ *No Conflict*: a counter-factual scenario simulating Yemeni development in the absence of conflict from 2014-2030.
- ▶ *Conflict 2030*: a scenario that is calibrated to Yemeni development during conflict (from 2014-2019) that also projects the future impact of conflict on development (from 2020-2030).

Using these scenarios, we show that the *conflict-attributable* impact of war in Yemen on development through 2019 includes:

- ▶ Pushing 11.7 million people into extreme poverty;
- ▶ Thrusting 4.9 million people, including 600,000 children younger than five into malnourishment;
- ▶ Reducing economic in growth by USD 88.8 billion; and,
- ▶ Driving Yemen to be the second-most unequal country in the world.

The uniquely large impact of war on development in Yemen is driven by two factors: (1) the country is, and has historically been, very dependent on food imports; and, (2) unlike some conflict countries, the population is largely unable to emigrate (for political and geographic reasons).

It is irrefutable that the conflict has cause a uniquely large amount of suffering, but it is less clear as to how to mitigate that suffering. A range of alternative policy choices are available.

The final section of this report evaluates how distinct *development pathways* reflecting these choices can reduce suffering in Yemen. To analyze these dynamics, this report uses four alternative scenarios that find the following:

- ▶ Increasing *Household Consumption* raises demand for food and reduces poverty but has a limited impact on overall malnutrition, as it does little to increase the supply of food;
- ▶ Improving *Food Distribution* reduces both adult and child malnutrition but does not significantly reduce poverty or increase incomes;

- ▶ Increasing access to *Water and Sanitation* improves human well-being in the long-run by reducing communicable disease prevalence and malnutrition; and,
- ▶ Targeting *Child Malnutrition* reduces human suffering and lowers stunting associated with severe child undernutrition but does little to reduce poverty.

A final scenario models the impact of ending the conflict in Yemen at the end of 2019. In the *Conflict Ends 2019* scenario millions are lifted out of poverty, hunger is improved, economic activity increased, and income inequality reduced.

Figure 2 measures the progress toward SDG achievement across the scenarios analyzed in this report. In the *No Conflict* scenario, Yemen is projected to close the gap to full SDG achievement by 45 per cent.<sup>2</sup> In the *Conflict 2030* scenario, however, Yemen's SDG progress is reversed by 67 per cent compared to 2015. The four additional development pathway scenarios also show set-backs relative to 2015 values.

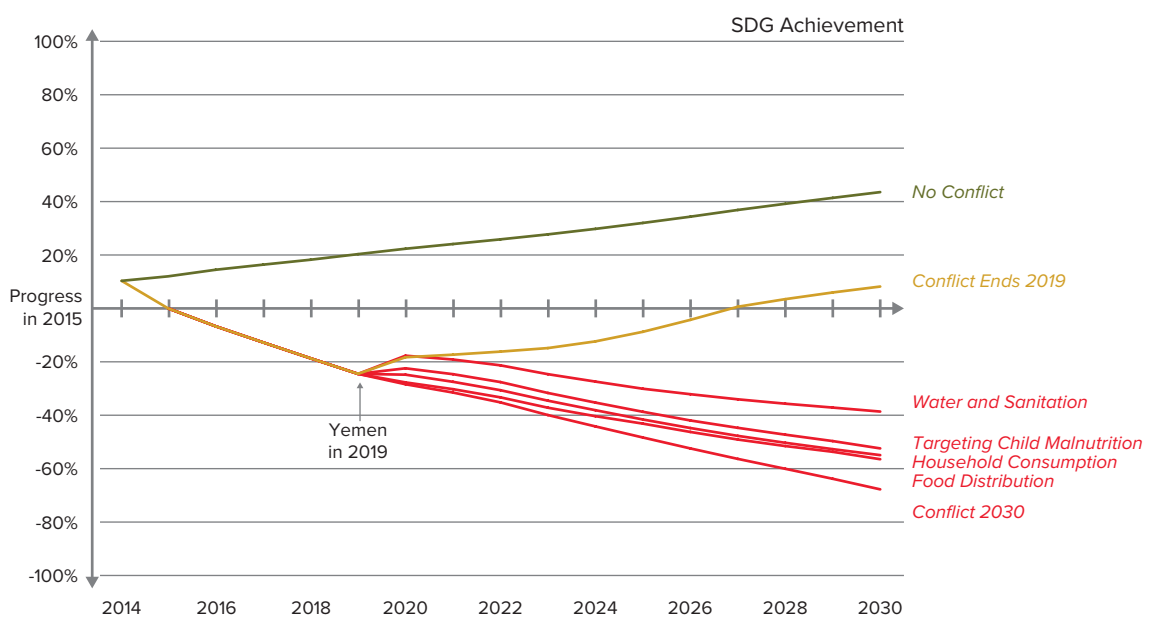
The only scenario explored in this research where developmental progress rebounds relative to 2015 levels

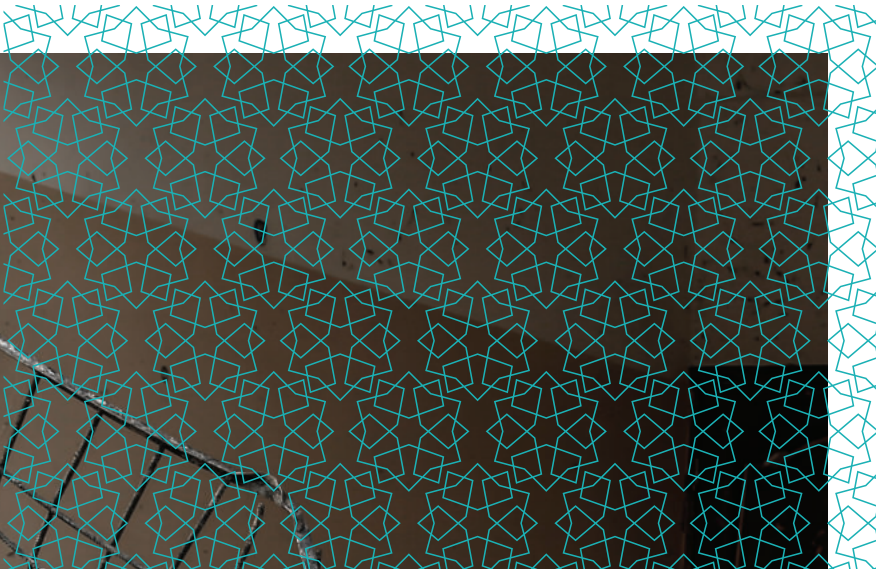
is *Conflict Ends 2019*. Should the conflict end, it is projected that by 2030 Yemen will be eight per cent closer to achieving some of the SDGs than it was in 2015 due to—among other factors—increased economic growth and reduced poverty and malnutrition. Though, even in this scenario developmental gains are extremely limited and barely reach levels of development prior to conflict.

If Yemen remains at war through 2030, the costs will be generational. Not only will the overwhelming portion of Yemenis live in poverty, but the depth of poverty will be the worst in the world. The population overwhelmingly will be malnourished, and many of those who survive will be faced with lifelong stunting, along with the associated impacts on health, education and productivity. The economy will be fundamentally altered, with GDP per capita ranking among the worst globally. And severe inequality will tear at the social fabric, making Yemen more vulnerable to an ongoing and vicious cycle of conflict, regional instability, and suffering.

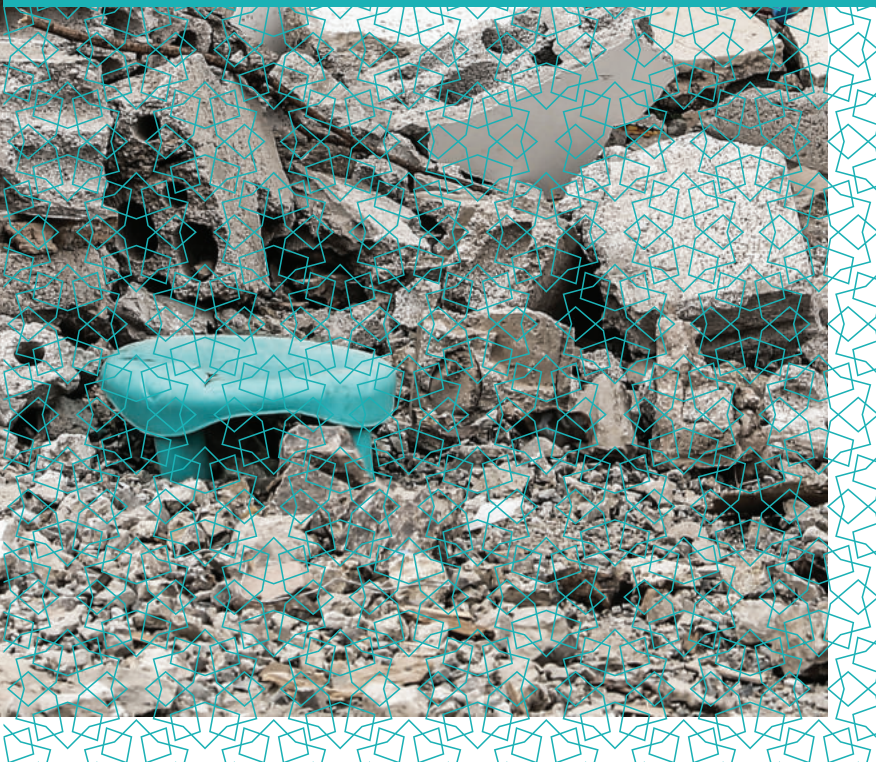
This research shows that there are no paths to significantly mitigating this suffering during conflict. The only reasonable path forward is to end the war.

**FIGURE 2 |** *Weighted average distance from SDG achievement across alternative scenarios. Vertical axis represents distance from SDG achievement benchmarked to 2015 values in the conflict scenarios (causing the No Conflict scenario values to be greater than zero in 2015).*





# INTRODUCTION





**Y**emen has been embroiled in an internationalized civil war since early 2015. The conflict has been especially destructive in terms of direct violence as well as the indirect damage caused by economic collapse and the interruption of food supplies. Combined with pre-existing challenges such as a sluggish economy, a rapid rise in population, food insecurity, and heavy dependence on oil, gas and remittances, the war has pushed Yemen into a crisis.

The population has few opportunities for emigration, driven by both political choices in the region and geographic barriers. Most of the population is in the west which is bordered by the Red Sea. The east is more sparsely populated and is largely covered by the Rub'al Khali desert, bordered by the Gulf of Aden and the Arabian Sea.

This report is the second in a three-part series exploring the impact of the war on Yemen's development.

Released in April 2019, a United Nations Development Programme (UNDP)-commissioned report established a methodological framework to understand the impact of conflict on development in Yemen.<sup>3</sup> It that found if conflict continues through the end of 2019, it will have set development back by over two decades.<sup>4</sup> And the longer conflict persists, the further back development regresses.

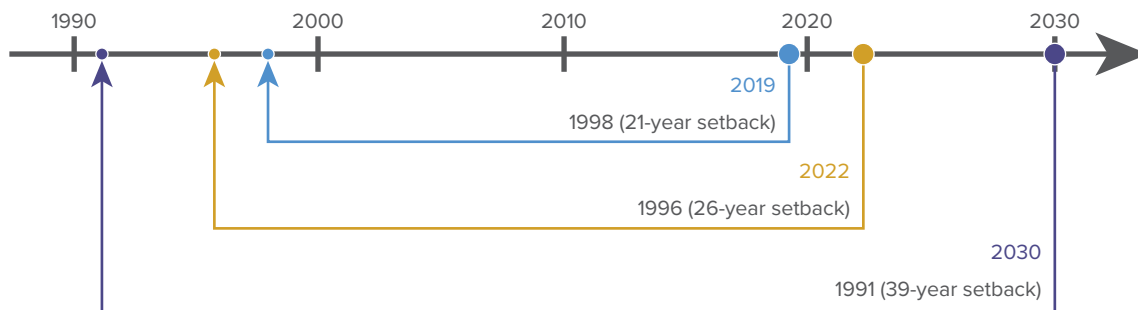


**BOX 1 | Key findings from the first report in this series, *Assessing the Impact of War on Development in Yemen*.**

Already, the impacts of the current war in Yemen place it among the most destructive conflicts since the end of the Cold War. Its death toll is increasingly dominated by indirect deaths whereby more people are killed due to the war's impacts on access to food, health services and infrastructure than are killed due to direct conflict violence. As the war continues, the burden will continue to be overwhelmingly felt by children under the age of five; currently more than half the war's victims are in this age group. If the conflict persists through 2030, it is projected that it will be responsible for the deaths of 1.5 million children.

**FIGURE 3 | How long does conflict in Yemen set back human development?**

Human Development Index  
years set back at the end of the conflict



If the war in Yemen were to end in 2019, it would be responsible for:

- ▶ 233,000 deaths of which 131,000 are due to indirect causes such as lack of food, health services, and infrastructure, and 140,000 are of children younger than 5
- ▶ Reversing human development by 21 years
- ▶ One child death every 11 minutes and 54 seconds
- ▶ A loss of nearly USD 89 billion in economic output

If the war continues through 2030, it is projected to be responsible for:

- ▶ 1.8 million deaths, with 1.48 million due to indirect causes and 1.5 million deaths of children younger than 5
- ▶ Reversing human development by 39 years
- ▶ One child death every 2 minutes and 24 seconds
- ▶ A loss of USD 657 billion in economic output

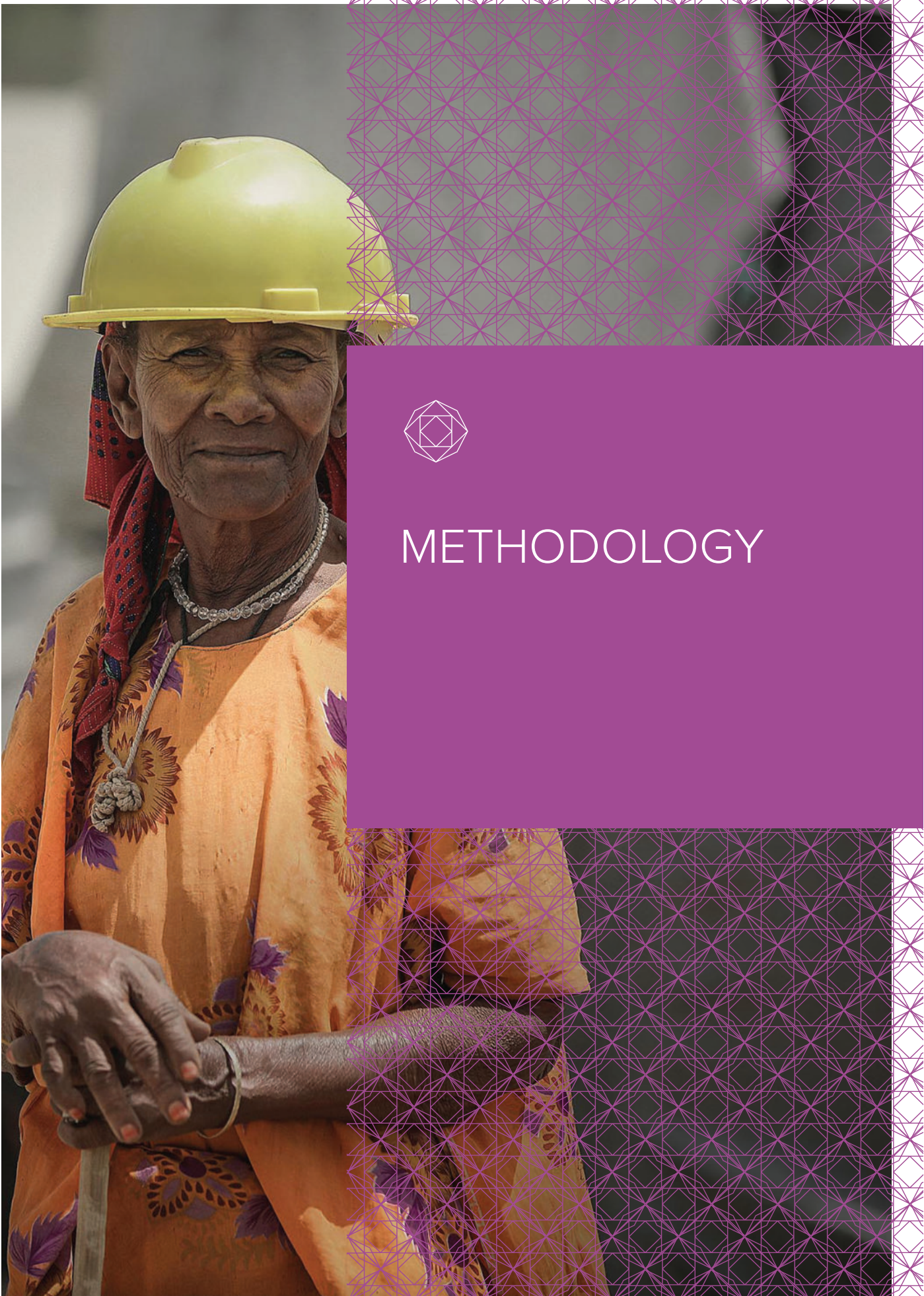
The Sustainable Development Goals (SDGs) are a collection of 17 global goals agreed to in 2015, set by the United Nations (UN) General Assembly and supported by UN Member States. With an aim to be achieved by 2030, the interrelated goals have measurable targets intended to “leave no one behind.” In Yemen, they provide a useful lens for evaluating how dire the situation has become as they compare: (a) human development across multiple dimensions; (b) the likelihood of achieving development targets and indicators; and, (c) how development progress compares to other countries.

The report seeks to understand how the conflict has

impacted Yemen’s ability to achieve the SDGs while assessing their interconnectivity during an ongoing conflict. It examines how conflict has reduced Yemen’s ability to specifically achieve four of the SDGs: SDG 1: *No Poverty*; SDG 2: *Zero Hunger*; SDG 8: *Decent Work and Economic Growth*; and, SDG 10: *Reduced Inequalities*. The report further explores alternative scenarios to understand conflict dynamics and potential impacts of interventions: (a) increasing household consumption; (b) improving the availability and distribution of food; (c) improving access to safe water and sanitation; (d) targeting child malnutrition; and, (e) ending the conflict.







# METHODOLOGY



This report builds upon the methodology used in the first report, *Assessing the Impact of War on Development in Yemen*,<sup>5</sup> where the International Futures (IFs)<sup>6,7,8</sup> tool was used to assess the developmental costs of conflict in Yemen by simulating the conflict from 2014–2030 as well as a scenario in which conflict did not escalate after 2014.

In the previous report, IFs was calibrated using Yemen-based data and estimates from 2015 to present. The model was calibrated in stages, beginning with the variables measuring the largest and most direct effects of conflict and assuming the following: (a) direct conflict deaths; (b) the magnitude of conflict; and, (c) GDP growth rates.

After adding the assumptions to IFs, their impact was explored on other indicators starting with the first-round calibration set: agricultural production, trade, and basic access to education and infrastructure services. Calculated variables were compared with other estimates and adjusted accordingly. After completing the first round of calibration, rounds two and three were conducted. The output was a model that reflects the impact of Yemen’s conflict on development through early 2019. A more detailed description of the calibration process is available in Appendix A.

Two alternative future scenarios were constructed that are outlined in later sections in the report. The first, a

counterfactual *No Conflict* scenario, simulates a world in which there was no conflict in Yemen after 2014 and reflects a plausible development trajectory for Yemen in the absence of increased conflict. It is used as a benchmark to compare against alternative conflict scenarios. The second is a *Conflict 2030* scenario whereby the conflict continues through 2030 at reduced severity across time.

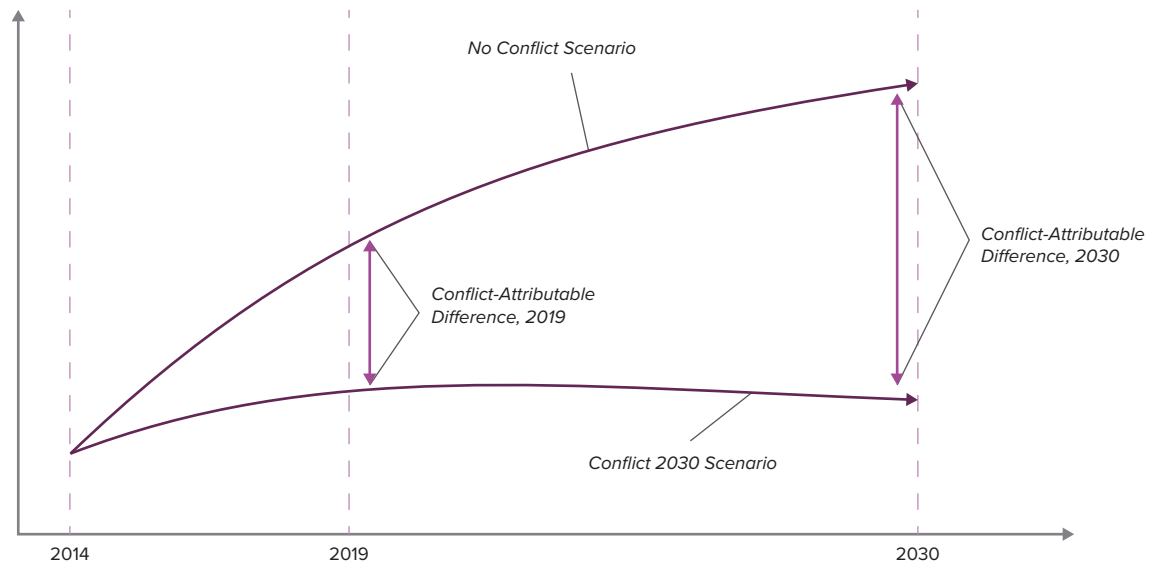
Four alternative versions of the conflict scenario were created to assess how changing development indicators can impact human well-being in ongoing conflict. For these scenarios, policy-relevant development indicators were reverted to 2014 levels and analyzed as to how they improve development more broadly in Yemen. Refer to Appendix B for more technical details on scenario assumptions. A final scenario—*Conflict Ends 2019*—represents the impact of ending conflict on development in Yemen.

Throughout the analysis the *conflict-attributable* impacts are analyzed. These are the isolated impacts of war on different aspects of human development

**TABLE 1 | Scenarios used in this report**

Scenario		Description
No Conflict		A counterfactual scenario simulating development across issue areas without conflict ever having erupted. Representative from the end of 2014 through 2030.
Conflict 2030		A scenario calibrated to the Yemen conflict from 2014 through 2019 and a projected continuation of conflict through 2030, though at reduced intensity across time.
Development Pathways (all interventions start after 2019 and modify the Conflict 2030 scenario)	Household Consumption	A scenario of sustained conflict in which households have increased purchasing power.
	Food Distribution	A scenario of sustained conflict in which food is more effectively imported and distributed.
	Water and Sanitation	A scenario of sustained conflict in which access to improved water and sanitation increases.
	Targeting Child Malnutrition	A scenario of sustained conflict in which malnutrition, especially severe acute malnutrition (SAM) among children reduces.
Conflict Ends 2019		A scenario where conflict in Yemen terminates at the end of 2019 and development patterns rebounds through 2030.

**FIGURE 4** | Illustration of a “conflict-attributable” difference in this analysis. The “conflict-attributable” impact on a particular indicator is the difference between the indicator value in the *No Conflict* scenario and a scenario that includes conflict.



controlling for a country’s broader developmental context. The *conflict-attributable* impact is an important measure because it tells us what the conflict is itself doing to development patterns. The analysis in this report most frequently identifies the conflict-attributable impact on development by comparing the

*No Conflict* scenario and the *Conflict 2030* scenario. However, in the final section analyzing development pathways, additional scenarios are compared.

See Figure 4 for an illustration of how a conflict-attributable impact is calculated.

## Methodological Limitations

There are various limitations to this study. Beyond those discussed in the first report, a new challenge emerged in this study when comparing the impacts of various *Development Pathways* to those of the *Conflict 2030* scenario.

The report creates scenarios reflecting improved sectoral development during conflict. This process changed some indicators to 2014 levels and examined how a change in one variable impacts development elsewhere. This makes the scenario interventions comparable in one way but simulates unrealistic policy options. For example, when the household consumption

levels are increased to 2014 levels, the growth from the 2019 estimation is USD 6.8 billion, well exceeding current levels of foreign assistance in Yemen.

The utility of the *Development Pathway* scenarios is their ability to help make development dynamics more transparent and understandable. They can help determine what ambitious development programmes could achieve and how these interventions are likely to create trade-offs with other development systems. This helps to understand the development dynamics and unique characteristics of the Yemen conflict that both enable and constrain development potential.

The treatment of uncertainty is another methodological challenge as data used in this report to analyze the ongoing conflict are taken from other researchers analyzing a very complex and uncertain space. As such,

the constructed scenarios are not meant to comprehensively frame the range of possibility in the unfolding conflict. This has resulted in a caveat on how to interpret results based on this analysis.

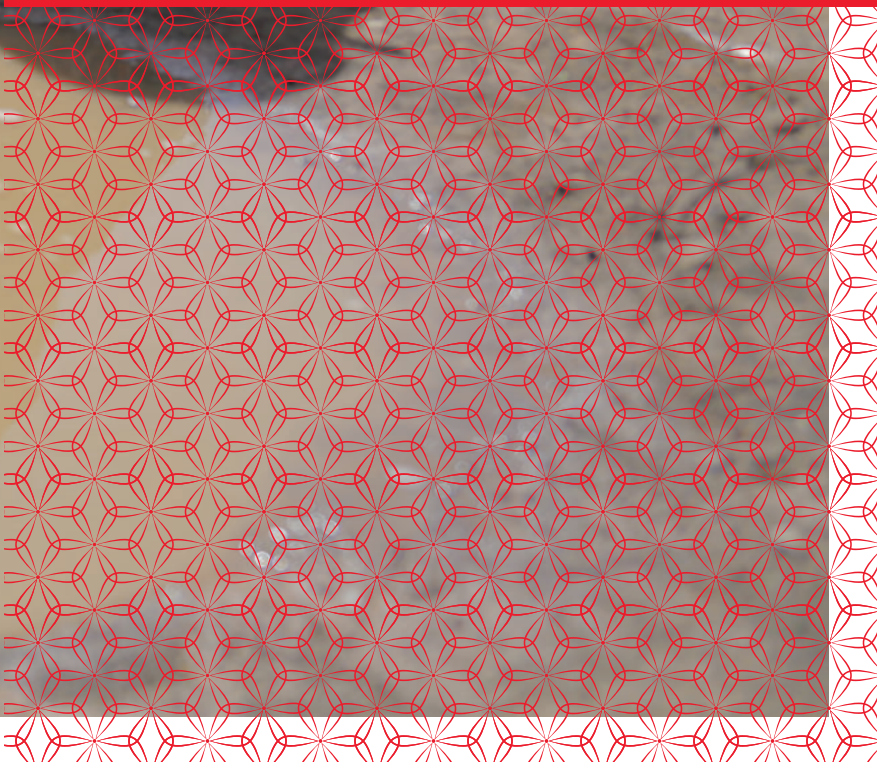
While some results are presented in very specific terms (e.g. 71.1 per cent of the population pushed into extreme

poverty by 2030 comparing the *Conflict 2030* scenario with the *No Conflict* scenario), it is not intended as a prediction of what will happen. Rather, model results should be used as inputs that help encourage thought about the integrated nature of development. Results should be understood as general projections that include implicit uncertainty that is not explicitly made.





# SDG 1: NO POVERTY





## Introduction

The aim of SDG 1 is the elimination of poverty. For this report, the measure of extreme poverty is the population living below USD 1.90 a day and poverty is the population living on less than USD 3.10 a day.<sup>9</sup> Another measure, the poverty gap, represents the depth or intensity of poverty by estimating how far a given population is from a defined threshold. For example, if a country has a high poverty gap, the impoverished are living far below the poverty line and it will take greater effort to eliminate poverty.

The measures used in this report are identified in Table 2.

Poverty in Yemen has been on the rise since 1998<sup>10</sup> due to sluggish economic growth, a lack of employment opportunities, and low-level conflict throughout the country.<sup>11</sup> The population living below Yemen's national poverty line grew from 35 per cent in 2005 to 42 per cent in 2009, and then increased to 54 per cent in 2011 due to unrest and economic contractions.<sup>12</sup> After the 2011 crisis, recovery was hindered by the forced return of hundreds of thousands of Yemenis working in Saudi

Arabia—which was of particular concern as remittances made up 10 per cent of GDP before 2011.<sup>13</sup>

By 2014, an estimated 12.9 million people in Yemen lived in poverty (nearly half of the population), with 4.9 million of those living in extreme poverty (19 per cent of the population<sup>14</sup>). Nearly half of the poor in the Middle East and North Africa (MENA) region lived in Yemen, (49.6 per cent of regional extreme poverty), despite the country accounting for just 6.2 per cent of the region's population.

**TABLE 2 | Poverty measurement overview.**

Poverty measures used in IFs		
Indicator	Description	Data Source
Per cent less than USD 1.90 per day	The per cent of the population that is living on less than USD 1.90 per day.	World Bank World Development Indicators (WDI), Tiwari et al. (2017), <sup>15</sup> Arezki et al. (2018, two studies) <sup>16</sup>
Per cent less than USD 3.10 per day	The per cent of the population that is living on less than USD 3.10 per day.	Estimated by using data and projections from USD 1.90 and USD 3.10 level values, with other structural drivers such as Gini coefficient and population. <sup>17</sup>
Poverty gap index at USD 1.90 <sup>18</sup>	The mean shortfall in income of the total population from the poverty line defined at USD 1.90 per day. Captures the relative “depth” of poverty.	World Bank WDI <sup>19</sup>

## No Conflict Scenario: Poverty

Yemen would have still faced considerable challenges in a world free from conflict, including a rapidly growing population, unemployment, and a lack of access to critical services. But the absence of conflict would increase productive activities, with human and financial resources no longer constrained by fighting.

In a *No Conflict* scenario, relative to 2014, the portion of Yemen's population living in poverty is projected to have been halved by 2030 (reducing the number by

3.1 million), and those living in extreme poverty would have fallen by two-thirds (reducing the number by more than 2.4 million). Notably, the poverty gap index would have been reduced five-fold, from 4.5 in 2014 (56<sup>th</sup> highest globally) to 0.9 in 2030 (70<sup>th</sup> highest globally). In this scenario, however, rapid population growth would have led to an increase of 640,000 in the absolute number of people living in poverty by 2022 relative to 2014.

While these reductions would have been laudable, they would have fallen short of achieving *SDG 1: No Poverty* with one of every four Yemenis still in poverty by 2030.

## Conflict Scenario: Poverty

By destroying household assets and livelihoods, war often leads to higher levels of poverty.<sup>20</sup> The conflict in Yemen has stalled economic growth, disrupted household income, and pushed millions into destitute conditions.<sup>21</sup> In 2016, the payment of salaries in the public sector—which employed 30 per cent of working Yemenis<sup>22</sup>—was suspended due to a liquidity crisis and has yet to fully resume.<sup>23</sup> In the private sector, a third of businesses shuttered with many more cutting operations, resulting in massive layoffs affecting both formal and informal workers.<sup>24</sup>

Should the conflict continue through the end of 2019, it is estimated that the portion of the population living in poverty will grow from just under half in 2014 (12.4 million) to 75 per cent in 2019 (22.3 million). And if the conflict continues through 2030, it is expected to reach as high as 88 per cent (34.1 million).

More troubling, however, is that the majority of those in poverty are extremely poor. The per cent of the population living in extreme poverty will have grown from 18.8 per cent in 2014 to 58.3 per cent in 2019. It is projected that if the conflict continues through 2030 this will grow to nearly 80 per cent (30.1 million).

While the number of people living under these poverty thresholds has increased with growth in the conflict,

so has the depth of poverty. By the end of 2019, it is estimated that Yemen's poverty gap will have increased from 4.5 in 2014 to 31.7 per cent, perpetuated by persistent conflict. By 2030, with continued but decreasing conflict, Yemen's poverty will be more widespread and over 11 times more intense than in 2014.

Figure 5 compares Yemen's poverty gap across two scenarios—one with *No Conflict* and one with *Conflict 2030*. Compared to all countries' IFs *Current Path*, estimates suggest that the depth of poverty in Yemen has grown very rapidly, surpassing 51 countries in rank since 2014. With continued conflict, Yemen will surpass four more countries by 2022, resulting in it having the greatest poverty in the world.

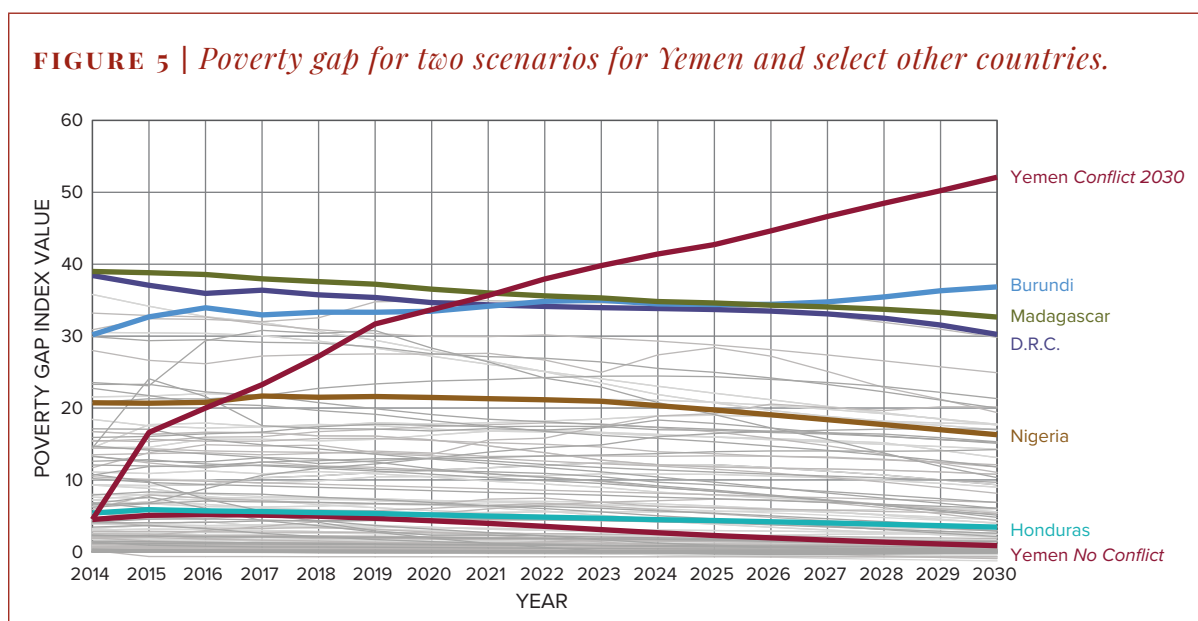
By comparing the *No Conflict* and the *Conflict 2030* scenarios, it is possible to obtain the poverty-related conflict-attributable growth—those who are impoverished today who would not be had the conflict not escalated. By the end of 2019, the conflict will have pushed an additional 8.6 million people into poverty and 11.7 million people into extreme poverty. In 2022, the conflict will be responsible for 12.4 million people in poverty and 15.8 million in extreme poverty. And by 2030 these figures grow to 24.9 and 27.6 million, respectively. The war will have increased the depth of poverty in Yemen by nearly 600 per cent by the end of 2019 and nearly 6,000 per cent by 2030 compared to a scenario without conflict.

**TABLE 3 | Poverty measures in a No Conflict scenario, in a scenario with conflict, and the conflict-attributable difference between the two.**

	Poverty in a No Conflict Scenario				Poverty in a Conflict Scenario				Conflict-Attributable Difference*			
	2014	2019	2022	2030	2014	2019	2022	2030	2014	2019	2022	2030
Per cent of population under USD 1.90/day	18.8	18.7	15.4	6.6	18.8	58.3	64.8	77.6		39.6	49.4	71
Per cent of population under USD 3.10/day	47.3	45.9	40.7	24.4	47.3	75	79.4	87.8		29.1	38.7	63.4
Millions of people under USD 1.90/day	4.9	5.6	4.9	2.5	4.9	17.3	20.7	30.1		11.7	15.8	27.6
Millions of people under USD 3.10/day	12.4	13.7	13	9.2	12.4	22.3	25.4	34.1		8.6	12.4	24.9
Poverty gap index (USD 1.90)	4.5	4.7	3.5	0.9	4.5	31.7	38	52.1		27	34.5	51

\*Where the unit is a per cent, the conflict-attributable difference is presented in percentage points.

**FIGURE 5 | Poverty gap for two scenarios for Yemen and select other countries.**







## SDG 2: ZERO HUNGER



## Introduction

**S**DG 2 focuses on the elimination of hunger and the promotion of food security. Food security exists when food is sustainably available, affordable, and people have access to quality water and sanitation—key drivers of undernutrition.

Systems of food security in Yemen were poor prior to the conflict. Historically, Yemen’s agricultural production was geared toward farming traditional drought-resistant staples using sustainable irrigation and terracing systems. But over the latter half of the twentieth century, this focus shifted toward more water-intensive crops, including fruits, vegetables, and, overwhelmingly, *khat*.<sup>25</sup> A popular plant chewed as a stimulant, *khat* is both highly profitable and water-intensive, taking up a considerable portion of agricultural land under cultivation. Along with this production shift, Yemen became overwhelmingly dependent on food imports<sup>26</sup> and, as a result, highly vulnerable to food security shocks.

Food security deteriorated markedly after unrest in 2011, resulting in a 40 per cent increase in food insecurity and an 87 per cent increase in severe food

insecurity, compared to 2009 levels.<sup>27</sup> By 2014, modest improvements had been made, from 45 per cent of the population being food insecure in 2011 to 41 per cent in 2014.<sup>28</sup> But progress was constrained by high food prices, low incomes, limited opportunities for employment, high healthcare costs, water scarcity, and insecurity and violence.<sup>29</sup>

In 2014, over one quarter of Yemen’s population—an estimated 6.6 million individuals—were malnourished, lacking enough calories for their minimum energy requirements. Over 4 in 10 children (1.6 million) suffered from general malnutrition, over 200,000 children suffered from SAM and 1.7 million were stunted.

The measures used in this report are identified in Table 4.

Hunger and food security indicators used in IFs		
Indicator	Description	Data Source
Calories per capita	The average per capita allotment of calories across the total population.	Food and Agriculture Organization (FAO)
Per cent of children malnourished	The per cent of the child population (under age 5) with a weight-for-age more than two standard deviations below international reference median value.	World Bank WDI <sup>30</sup>
Per cent of population undernourished	The per cent of the population that is not meeting the minimum daily energy requirement.	FAO suite of food security indicators <sup>31</sup>
Severe acute malnutrition (SAM) headcount	The number of children who have a weight-for-height that is more than three standard deviations below the international reference median value.	UNICEF, WHO, World Bank Group
Per cent of children stunted	The per cent of the child population (under age 5) who have a height that is more than two standard deviations under the median international reference value for age.	Estimated as a function of malnourished children



## **No Conflict Scenario: Food Security & Hunger**

In the absence of conflict, it is projected that income growth and infrastructure improvements would have led to continued progress in reducing malnutrition, ultimately saving lives and benefiting long-term development. In 2014 Yemen's calories per capita (2,260) was on par with the average calories per capita available in low-income countries. In a *No Conflict* scenario, it is estimated that by 2030, the calories per capita would have grown steadily to 2,500.

As such, in a *No Conflict* scenario, it is projected that the malnourished per cent of the population would decline from 25 per cent in 2014 (6.6 million people) to 20 per cent in 2019, and to less than 12 per cent (4.5 million people) by 2030.

Children are especially vulnerable to undernourishment as they become undernourished faster than adults and have a higher risk of death from starvation.<sup>32</sup> Undernutrition is a cause of nearly half of all childhood deaths worldwide.<sup>33</sup> Moreover, undernutrition in life's

first two years results in irreversible damage, leading to lower levels of schooling and economic productivity in adulthood.<sup>34</sup>

In a *No Conflict* scenario, the number of malnourished children would have declined from 1.7 million children (42 per cent of the under-5 population) in 2014 to 1.6 million in 2019 (37 per cent) and 1.1 million (25 per cent) by 2030.

In 2014 Yemen's prevalence of severe acute malnutrition (SAM) (5.2 per cent) and child stunting (43 per cent) were among the highest in the world. In a *No Conflict* scenario, SAM prevalence is projected to have fallen from 5.2 per cent in 2014 to 3 per cent by 2030. The per cent of stunted children was also projected to fall from 43 per cent in 2014 (1.7 million) to 30 per cent by 2030 (1.4 million).

In the absence of conflict, malnutrition in Yemen would have improved, with thousands of children pulled out of hunger. These improvements would not have been enough to meet the SDG 2 goals of eliminating hunger and malnutrition in all forms, but the country's population would have been healthier and more productive than in 2014.

## Conflict Scenario: Food Security & Hunger

Globally, most undernourished people live in countries experiencing violence and fragility.<sup>35</sup> The impact of conflict is multifaceted as it can decimate food systems, leading to widespread hunger;<sup>36</sup> lower agricultural yields and reduce land under cultivation; disrupt the import and distribution of food; and, destroy or degrade water and sanitation systems.

By damaging the economy, conflict reduces household incomes and the ability to buy food. Conflict in Yemen has drastically reduced food imports due to restrictions, a lack of purchasing power and limited foreign

exchange.<sup>37</sup> In November 2017, a total port closure immediately and significantly reduced access to food, leading to significant price spikes<sup>38</sup> and forcing some households to reduce consumption.<sup>39</sup> Still today, food imports have not yet recovered to levels prior to the closure.<sup>40</sup>

Yemen's already vulnerable food system has been decimated—destroying or disrupting food production and distribution. Ruined water and sanitation infrastructure further reducing the efficiency of calories that are consumed, ultimately compounding malnutrition, stunting and loss of life. A recent analysis found that roughly half the population faced severe acute food insecurity despite ongoing assistance.<sup>41</sup> And destroyed water and sanitation infrastructure further reduces the efficiency of calories that are consumed, compounding the problem of malnutrition.<sup>42</sup>

**TABLE 5 | Hunger measures in a No Conflict scenario, in a scenario with conflict, and the conflict-attributable difference between the two.**

	Hunger in a No Conflict scenario				Hunger in a Conflict scenario				Conflict-attributable difference*			
	2014	2019	2022	2030	2014	2019	2022	2030	2014	2019	2022	2030
Malnourished population (per cent of population)	25.2	19.5	17.4	11.8	25.2	36.1	48.2	95.5		16.6	30.9	83.8
Malnourished population (millions)	6.61	5.8	5.55	4.46	6.6	10.7	15.4	371		4.9	9.8	32.7
Malnourished children (per cent of children)	42.1	36.5	33.5	24.6	42.1	50.4	57.3	79.5		13.9	23.9	54.9
Malnourished children (millions)	1.65	1.55	1.49	1.14	1.7	2.1	2.6	4.4		0.6	1.1	3.3
SAM prevalence (headcount in thousands)	207	165	161	138	207	400	421	502		0.2	0.3	0.4
Stunting (per cent of children)	42.6	38.1	35.8	29.8	42.6	50.2	57.1	84		12.1	21.3	54.2
Stunting (millions of children)	1.69	1.63	1.6	1.39	1.69	2.17	2.68	4.87		0.54	1.07	3.48
Calories per capita	2,261	2,326	2,368	2,504	2,261	1,792	1,651	1,500		-535	-717	-1,004

\*Where the unit is a per cent, the conflict-attributable difference is presented as percentage points.



## MALNUTRITION

Through the end of 2019, this report estimates that the undernourished population will grow by over 60 per cent (to over 10.7 million or 36.1 per cent of the population) compared to 2014 levels. If conflict persists through 2030, it is projected that over 95 per cent of Yemenis—approximately 37 million—will be malnourished.

This level of undernutrition would be unprecedented. Of available data starting in 1990, the highest levels of malnutrition have occurred in the countries of Georgia in 1992 (80.8 per cent), Djibouti 1992 (76.8 per cent) and Eritrea in 2000 (76.2 per cent).

By the end of 2019, the number of calories available per capita is projected to fall to 80 per cent of 2014 levels. If the war persists through 2030, it is estimated that this will be reduced to 66 per cent of the 2014 values—or a mere 1,500 calories per person. As such, child malnourishment is projected to increase from 42.1 per cent (1.7 million) to over half of all children (2.1 million) by the end of 2019. As the conflict continues, child malnourishment will continue to grow to an estimated 79.5 per cent (4.4 million) by 2030.<sup>43</sup>

## SEVERE ACUTE MALNUTRITION (SAM)

The conflict has also greatly increased the prevalence childhood SAM—from 5.2 per cent in 2014 to 9.2 per cent by 2019—resulting in Yemen having the second highest SAM prevalence after South Sudan. These numbers will continue to increase due to steady population growth. In absolute terms, it is projected that the number of children with SAM has increased from 207,000 in 2014 to 400,000 today and will increase to over 502,000 by 2030 if the conflict persists.

## STUNTING

Childhood stunting has long-term effects on cognitive development, educational achievement, productivity and earnings later in life.<sup>44</sup> Moreover, mothers who have been stunted are at higher risk for adverse reproductive outcomes.<sup>45</sup> And stunted populations reduce future economic activity.

If the conflict persists, the per cent of children who suffer from stunting will grow from 43 per cent (1.7 million) in 2014 to 84 per cent (4.9 million) in 2030. This dramatic increase will have an irreversible impact on



the mental and physical capacity of a large portion of Yemen's population and workforce. By 2050, it is projected that one-in-five additional adults will be stunted as a result of the conflict.

By comparing the *No Conflict* scenario to the *Conflict 2030* scenario, it can be determined how much of Yemen's challenges with hunger can be attributed to the direct and indirect effects of the conflict. Through 2019, conflict accounted for an average loss of over 500 calories per person, per day. By 2030, it will be responsible for an average of nearly 1,000 calories. As the war persists, it accounts for an increasingly larger

share of hunger-based suffering in Yemen—reversing the country's progress toward SDG 2.

Furthermore, the deterioration of the Yemeni water, sanitation and health sectors will lead to additional complications such as diarrheal disease, affecting the ability of people—particularly young children—to utilize ingested calories. Since the conflict began, an estimated 2.5 million people have lost access to improved sanitation and 3.5 million people have lost access to piped water. By 2030, the conflict-attributable difference in people with access to improved sanitation will reach over 12 million and for piped water it increases to 15 million.



## SDG 8: WORK AND ECONOMIC GROWTH



## Introduction

The aim of SDG 8 is to “promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.”<sup>46</sup> SDG 8 targets and indicators span a range of related issue areas, including gross domestic product (GDP) growth rates and employment rates, access to financial services, resource efficiency and labor rights.

The measures used in this report—either directly derived from or adjacent to SDG 8 indicators—are listed in Table 6.

Work and economic growth indicators used in IFs		
Indicator	Description	Data Source
Gross domestic product (GDP)	The total value added of all productive activities within the economy in a given year. All GDP measures are given in market exchange rates (MER).	International Monetary Fund (IMF) World Economic Outlook
GDP per capita	GDP at purchasing power parity (PPP) divided by the population of a country in a given year.	IMF World Economic Outlook, United Nations Population Division World Population Prospects
Annual growth rate of real GDP per capita	Annual growth rate of GDP, considering inflation, divided by total population for a given year.	IMF World Economic Outlook, United Nations Population Division World Population Prospects
Skilled labor, per cent of total Labor force	Portion of the labor force that consists of skilled versus unskilled workers. Skilled and unskilled classifications from the Global Trade Analysis Project (GTAP). <sup>47</sup>	International Labour Organization (ILO), GTAP
Human capital	Relative net contribution to productivity growth of “human capital” including: educational spending and attainment; life expectancy; stunting; disability; and, vocational training—given level of development.	Internal calculation, see Appendix C
Social capital	Relative net contribution to productivity growth of “social capital” including: educational spending and attainment; life expectancy; stunting; disability; and, vocational training—given level of development.	Internal calculation, see Appendix C
Physical capital	Relative net contribution to productivity growth of “physical capital” including: educational spending and attainment; life expectancy; stunting; disability; and, vocational training—given level of development.	Internal calculation, see Appendix C
Knowledge capital	Relative net contribution to productivity growth of “knowledge capital” including: spending on research and development (R&D); trade openness; and, the share of tertiary education degrees in Science, Technology, Engineering and Mathematics (STEM)—given level of development.	Internal calculation, see Appendix C





In the mid-2000s, Yemen's output steadily increased with GDP growth averaging 4.5 per cent per year. However, the economy suffered a 12 per cent drop in GDP growth after unrest in 2011. More than 40 per cent of small businesses reported lower sales and approximately 40 per cent layoffs of their workforce.<sup>48</sup> In 2012 and 2013—even with the setback—GDP growth was positive and the general trend for Yemen's economy, labor participation, and unemployment was one of steady, but limited, improvement.<sup>49</sup>

In 2014, the overall participation in the labor force was 36 per cent with a significant disparity between men (68 per cent) and women (6 per cent).<sup>50</sup> Unemployment was also considerably higher for women (26 per cent) than for men (12 per cent).<sup>51</sup> Of those employed, roughly

30 per cent worked in the public sector and half were self-employed.<sup>52</sup> The private sector was made up almost entirely of small and medium businesses with 97 per cent of firms employing fewer than 25 employees.<sup>53</sup> Those businesses faced numerous challenges, including poor infrastructure, low levels of investment, bureaucratic obstacles, and currency appreciation as a result of oil exports.<sup>54</sup>

Yemen's workforce generally had low levels of education—less than a third completed secondary education<sup>55</sup>—and 68 per cent of non-agricultural workers were employed informally.<sup>56</sup> The informal labor force often performs essential jobs—especially in a developing economy—but is typically less productive, more precarious for workers, and generates less revenue in taxes.<sup>57</sup>



## ***No Conflict scenario: Work & Economic Growth***

If conflict had not escalated in 2015, Yemen would have made progress toward the achievement of SDG 8, though still falling short of the target indicators. In a *No Conflict* scenario, it is projected that:

- ▶ GDP would have nearly tripled from 2014 (USD 35.7 billion) to 2030 (USD 100.3 billion)
- ▶ GDP per capita would have grown from USD 3,770 (2014) to USD 5,900 (2030)
- ▶ GDP per capita growth rate would have improved from -2.7 per cent (2014) to 2.3 per cent (2019) and 4.7 per cent (2030)

While these growth rates fall short of the SDG goal of seven per cent, they represent economic gains that would have brought Yemen's GDP per capita in 2030 to the level of Vietnam in 2018.

The overall growth in a *No Conflict* scenario is associated with modest labor improvements. In the absence of conflict, it is projected that labor participation would have remained relatively flat and

that unemployment would have fallen somewhat, from 13.5 per cent in 2014 to 9.9 per cent by 2030. Continued development and improving education would slowly increase the supply of skilled labor, growing the share of skilled labor from just under 40 per cent in 2014 to 43 per cent in 2030.

Economic productivity was also projected to improve. The IFs system calculates contributions to productivity across four major categories: human capital; knowledge capital; physical capital; and, social capital. These categories can act as a boost to productivity if they are higher than expected (a positive contribution) or a drag on productivity if they are lower (a negative contribution). See Appendix C for more information on these calculations.

Between 2015 and 2030, each of these categories is projected to have made negative contributions to productivity. But in the absence of conflict, economic growth and associated improvements in poverty and hunger, discussed in the sections above, would have allowed continued development of Yemen's education, health, infrastructure, and governance systems. As a result, the negative pull from these categories would have improved. The largest negative contribution to productivity in a *No Conflict* scenario stems from low levels of human capital driven by poor educational attainment, quality, and poor access to health services.

## Conflict scenario: Work & Economic Growth

Large-scale war has serious consequences for a country's economy.<sup>58</sup> It destroys physical and human capital directly, disrupts economic processes by breaking down social order, diverts public spending from productive activities, and destroys capital stock through excess spending.<sup>59</sup>

GDP per capita growth rates have averaged -13 per cent since 2015. Oil and gas production overall has fallen 90 per cent since 2014, leaving the country with limited foreign exchange and revenues.<sup>60</sup> Imports have been halved since 2014, with many imports now primarily informal.<sup>61</sup> GDP fell from USD 35.7 billion in 2014 to USD 20.1 billion by 2019 and GDP per capita fell from USD 3,770 to USD 1,950, a level not seen in Yemen since before 1960.<sup>62</sup>

If the conflict continues, it is projected that GDP will continue to decline, eventually being cut in half by 2022. GDP per capita will also continue to decline, shrinking two-thirds by 2030, relative to 2014. GDP per capita growth in a conflict scenario averages -6.4 per cent between 2015 and 2030. Yemen's global GDP per capita ranking, out of 186 countries in IFs, is projected to plummet from 138<sup>th</sup> in 2014 to 181<sup>st</sup> by 2030.

This economic collapse has had serious consequences for labor in Yemen. Before 2015 was over, roughly a quarter of businesses had already closed.<sup>63</sup> Companies are now reporting drastically lower sales, downsizing and relocation.<sup>64</sup> Private sector businesses have halved working hours and laid off an estimated 55 per cent of workers.<sup>65</sup>

In a 2016 survey of three areas—Aden, Hodeidah and Sana'a—the International Labour Organization (ILO) found that employment fell by nearly 13 per cent. Agricultural jobs were the most affected with only half of the previous employment opportunities. The study also found that women, young people, and self-employed workers were disproportionately affected.<sup>66</sup> Although data are unavailable, it is likely that the conflict has resulted in growing informal employment in Yemen. Conflict is associated with expanding informal employment through households coping with economic shock or displacement, the destruction or degradation of formal institutions, and by facilitating an illicit war economy.<sup>67</sup>

In terms of productivity, human capital remains a significant drag on productivity in a conflict scenario in Yemen.<sup>68</sup> Social capital—a measure of how governance and institutional effectiveness contribute to productivity<sup>69</sup>—takes the largest hit in the conflict scenario.

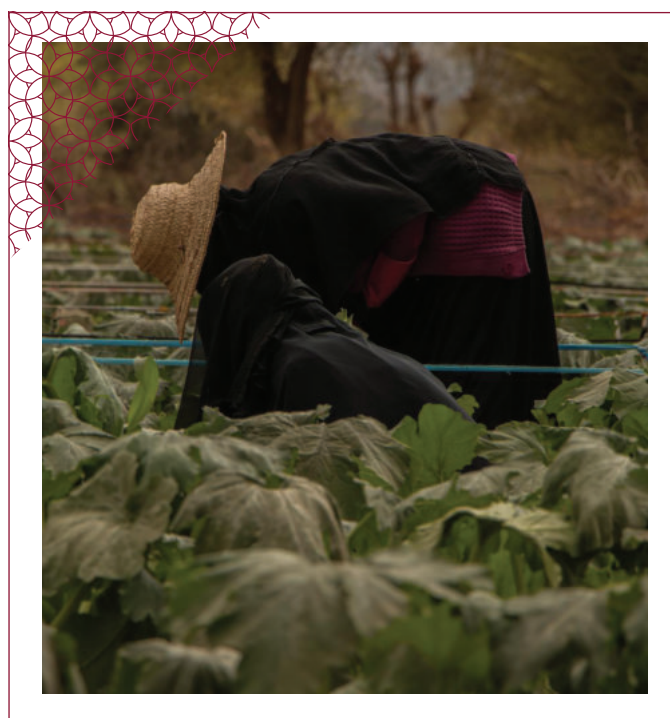


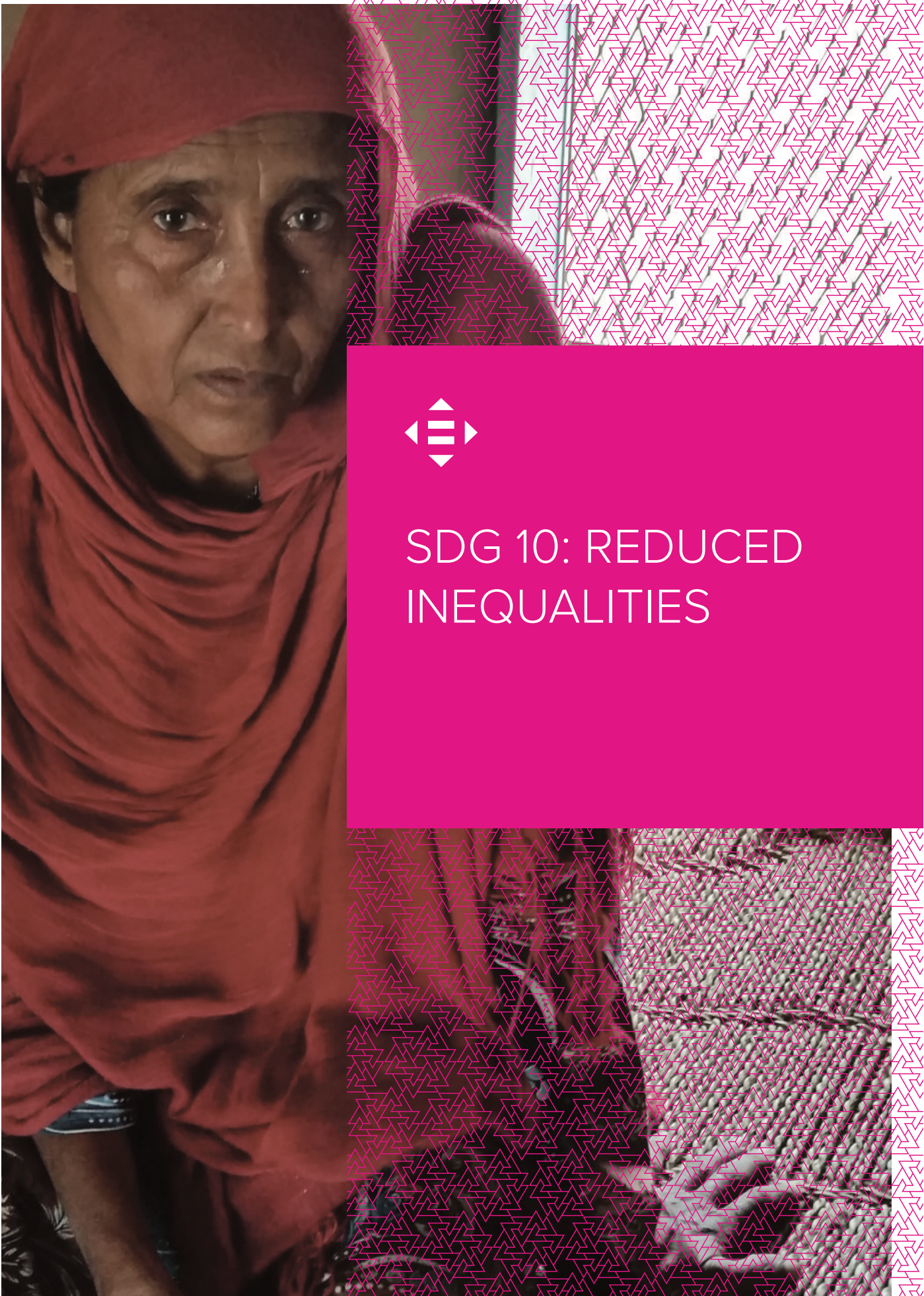
**TABLE 7 | Work and economic growth measures in a No Conflict scenario, in a scenario with conflict, and the conflict-attributable difference between the two.**

	Work and economic growth in a No Conflict scenario				Work and economic growth in a Conflict scenario				Conflict-attributable difference*			
	2014	2019	2022	2030	2014	2019	2022	2030	2014	2019	2022	2030
GDP at MER (billion)	35.7	44.1	52.9	100.3	35.7	20.1	18.5	15.6		88.8 <sup>†</sup>	180.8 <sup>†</sup>	656.9 <sup>†</sup>
GDP per capita at PPP	3,770	3,970	4,280	5,900	3,770	1,950	1,710	1,260		-2,020	-2,580	-4,650
Annual growth rate of real GDP per capita at PPP	-2.7	2.3	2.9	4.7	-2.7	-5	-5.1	-3.8		-7.3	-8	-8.5
Skilled labor (per cent of total labor force)	0.397	0.396	0.403	0.433	0.397	0.288	0.262	0.206		-0.11	-0.14	-0.23
Human capital	-0.03	-0.03	-0.02	-0.02	-0.03	-0.03	-0.02	-0.02		-0.01	0.00	0.00
Social capital	-0.01	-0.01	0.00	0.00	-0.01	-0.03	-0.02	-0.01		-0.03	-0.02	-0.01
Physical capital	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00		0.00	0.00	0.00
Knowledge capital	-0.01	-0.01	0.00	0.00	-0.01	-0.01	-0.01	0.00		-0.01	0.00	0.00

\*Where the unit is a per cent, the conflict-attributable difference is presented in percentage points.  
<sup>†</sup>The measures of conflict-attributable difference in GDP show the cumulative difference from 2015.

By comparing the *No Conflict* counterfactual scenario to one in which the current conflict persists, the conflict-attributable economic impacts can be determined. By the end of 2019, it is projected that the conflict will be responsible for reducing economic output by a cumulative USD 88.8 billion. And if it continues, the lost economic output grows to USD 180.8 billion by 2022 and USD 656.9 billion by 2030, 26-times the size of Yemen’s 2014 economy. In 2019, the conflict is responsible for a GDP per capita loss of USD 2,020—a figure which grows to USD 4,650 by 2030.





# SDG 10: REDUCED INEQUALITIES



## Introduction

SDG 10 focuses on reducing inequality “within and among countries”.<sup>70</sup> Societies can be characterized by inequalities across multiple dimensions including gender, social class, levels of income or wealth, education access, health care access, infrastructure access or disability. SDG 10 targets and indicators cover various types of inequality but place emphasis on income inequality. This report focuses on measures of income and gender inequality within Yemen.

The first target of SDG 10 is to achieve and sustain more rapid income growth for the bottom 40 per cent of the population; however, data is limited—particularly in the region.<sup>71</sup> Therefore, this report reviews the growth rate of household consumption at both the 20<sup>th</sup> percentile and the 50<sup>th</sup> percentile (the median). Should the 20<sup>th</sup> percentile grow faster than the 50<sup>th</sup> percentile, inequality would reduce.

Though not an SDG 10 indicator, the Gini coefficient<sup>72</sup> is the most commonly used measure of income inequality. And while gender equality is the focus of SDG 5, the report includes it in this section as several SDG 10 indicators contain gender measures and it is an important aspect of inequality.

The measures used in this report are listed in full in Table 8.

**TABLE 8 | Inequality measures overview**

Inequality measures used in IFs		
Indicator	Description	Data Source
Gini Coefficient	A measure of income inequality reflecting the relative distance from a perfectly equal distribution of income (higher is worse).	World Bank WDI
Gender Development Index (GDI)	The ratio of the Human Development Index between male and female used to track parity of development outcomes between the two groups.	United Nations Development Programme (UNDP)
Median consumption (USD per day)	Consumption per capita that divides the population into two groups of equal size. Typically, the more unequal a society is, the lower the median per capita income is relative to GDP per capita.	World Bank WDI poverty line data. Estimation using lognormal distribution assumptions, accounting for Gini.
Growth rate of 50th percentile consumption	The year-on-year change in size of income at the 50 <sup>th</sup> percentile of the income distribution.	World Bank WDI poverty line data. Estimation using lognormal distribution assumptions, accounting for Gini.
Growth rate of 20th percentile consumption	The year-on-year change in size of income at the 20 <sup>th</sup> percentile of the income distribution.	World Bank WDI poverty line data. Estimation using lognormal distribution assumptions, accounting for Gini.
Difference in growth rate of 50th and 20th percentile consumption	The difference between the growth rate of the 50 <sup>th</sup> percentile consumption and the growth rate of the 20 <sup>th</sup> percentile consumption.	Calculation from the above two measures
Growth rate of GDP per capita at PPP	The year-on-year change in size of mean per capita GDP at PPP.	IMF World Economic Outlook; UN Population Division: World Population Prospects
Gender ratio, educational attainment, 15+	The ratio of female to male average educational attainment across the total population aged 15 years or older.	Barro-Lee data <sup>73</sup>

Prior to 2015, Yemen's Gini coefficient for income inequality was close to the global mean—ranking 103 out of 186—growing somewhat over the past few decades<sup>74</sup> with income inequalities between rural and urban households widening.<sup>75</sup> Stark inequalities exist across governorates and between urban and rural areas in service provision, food insecurity and access to quality healthcare and electricity.<sup>76</sup>

Gender equality, however, is extremely poor—even before the 2015 conflict. Globally, Yemen ranked:

- ▶ The lowest in both the Gender Inequality Index<sup>77</sup> and the World Economic Forum's Gender Gap Index.<sup>78</sup>
- ▶ The lowest for female participation in the labor force at eight per cent.
- ▶ 174 out of 186 for the ratio of women's educational attainment (0.67) to men's (ages 15 and older).
- ▶ The second lowest for the country's Gender Development Index (GDI)—a summary of income, education and health outcomes. This is better than Somalia, but worse than Afghanistan.



## No Conflict Scenario: Exploring Inequalities

In the absence of conflict, it is projected that Yemen's income inequality would not have changed drastically between 2014 and 2030. This report projects that the Gini coefficient—together with the growth rates of the 20<sup>th</sup> and 50<sup>th</sup> percentiles of consumption—would have remained largely unchanged through 2030.

In the absence of conflict, gender equality was projected to show limited progress. The report projects

that the GDI would have grown by seven per cent between 2014–2019, not enough growth to improve Yemen's rank relative to other countries.

Additionally, gender parity in educational attainment in the *No Conflict* scenario was projected to improve slightly—seeing Yemen advance from 174 to 169 out of 186 countries. Across educational access measures—including enrollment, transition and graduation rates at various education levels—the gender parity ratio would also somewhat improve. Only in gross tertiary enrollment does the report project that Yemen could have achieved gender parity by 2030—in no small part due to low levels of attainment by men.

## Conflict Scenario: Exploring Inequalities

In Yemen, war appears to have greatly exacerbated the problem of income inequality. Research on the effects of conflict on inequality suggests that conflict can increase income inequality. There is evidence that in at least some situations, war could act as an inequality multiplier.<sup>79</sup> But the magnitude of impact is generally less<sup>80</sup> than what our modeling suggests about the case of Yemen.

The war has impoverished large sections of the population. And beyond pushing more people into poverty, it has greatly increased the depth of poverty, meaning that most Yemenis in poverty are much worse off than before. At the same time, some individuals and groups have benefited from a growing war economy.<sup>81</sup> Thus, while the poverty gap grows and many households at the bottom of the distribution suffer, others have used the war to enrich themselves, leading to growing inequality.

This is evident geographically as well. The fighting does not impact all of Yemen—in 2016, just 55 per cent of Yemen’s population and 30 per cent of its land area were affected by conflict.<sup>82</sup>

By the end of 2019, it is estimated that Yemen will have gone from a country with income inequality around the 50<sup>th</sup> percentile to the second-most unequal country in the world, after South Africa. By 2022, if conflict persists, it is expected that Yemen will be the most

unequal country for income distribution. And if the conflict continues until 2030, the Gini coefficient in Yemen is projected to be higher than 99 per cent of recorded values for all countries historically.

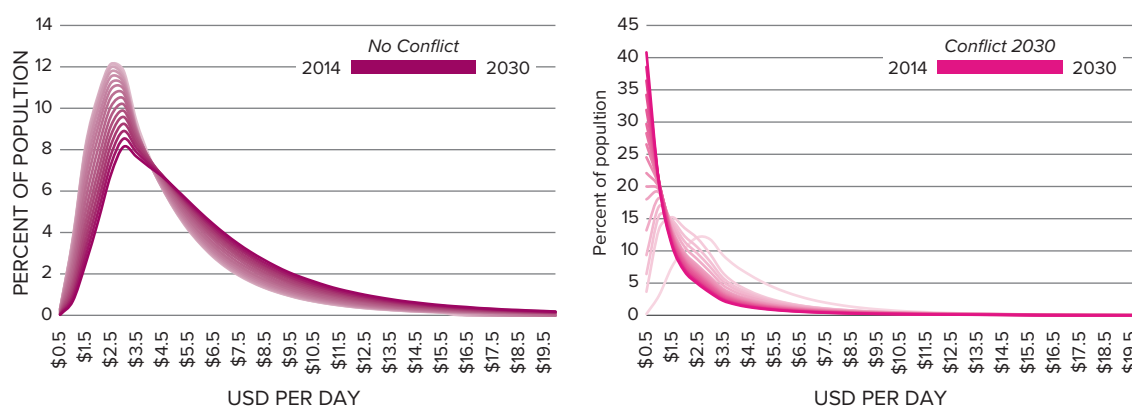
Figure 6 illustrates how the war has drastically altered the population’s income distribution.

This finding is also connected to household consumption growth rate of the 20<sup>th</sup> percentile. Since 2015, household consumption at both the 20<sup>th</sup> and 50<sup>th</sup> percentiles has fallen. However, annual growth in household consumption at the 20<sup>th</sup> percentile has fallen between six and eight percentage points faster than the 50<sup>th</sup> percentile, widening the gap between the two.

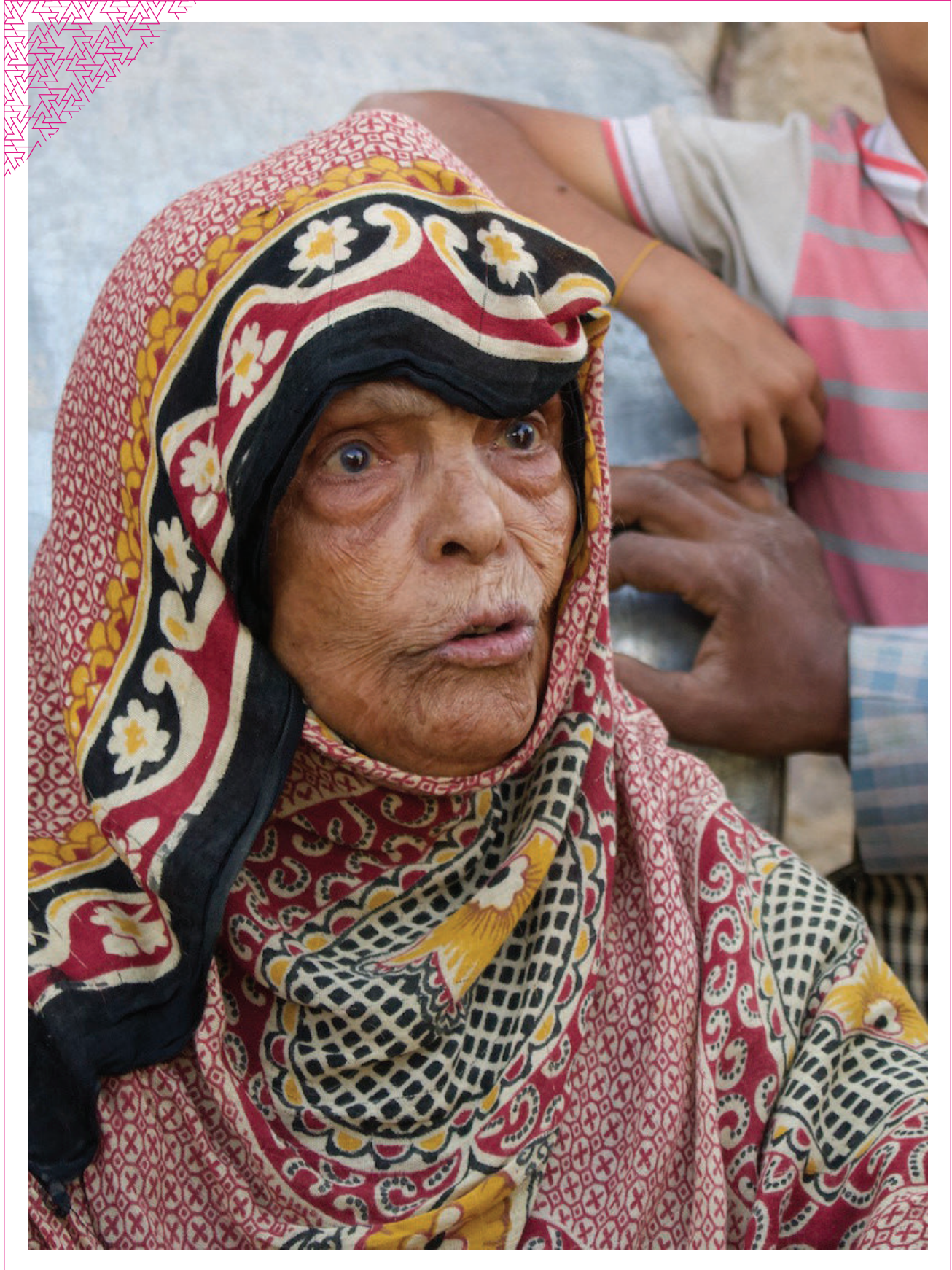
The conflict has also aggravated existing gender inequality and since 2014, Yemen’s already low GDI has further deteriorated. According to the Equal Measures 2030 SDG Gender Index, in 2019, Yemen ranks 126 of 129 countries—ahead of Chad, the Democratic Republic of Congo and the Republic of Congo.<sup>83</sup> There is evidence that the ongoing war has led to increased rates of child marriage and gender-based violence<sup>84</sup> with three-quarters of the displaced being women and children.<sup>85</sup> And if conflict continues, by 2030, Yemen’s gender development will be the worst of any country in the world.

Educational outcomes, however, have become slightly more gender-equal with the ratio of female to male attainment slightly increasing since 2014. Rather than reflecting an improved educational attainment among females, it reflects a reduction in education attained by males and backsliding in educational progress overall

**FIGURE 6 | Distributions of household consumption in Yemen by year for the No Conflict and Conflict 2030 scenarios (note vertical axes have different scales).**





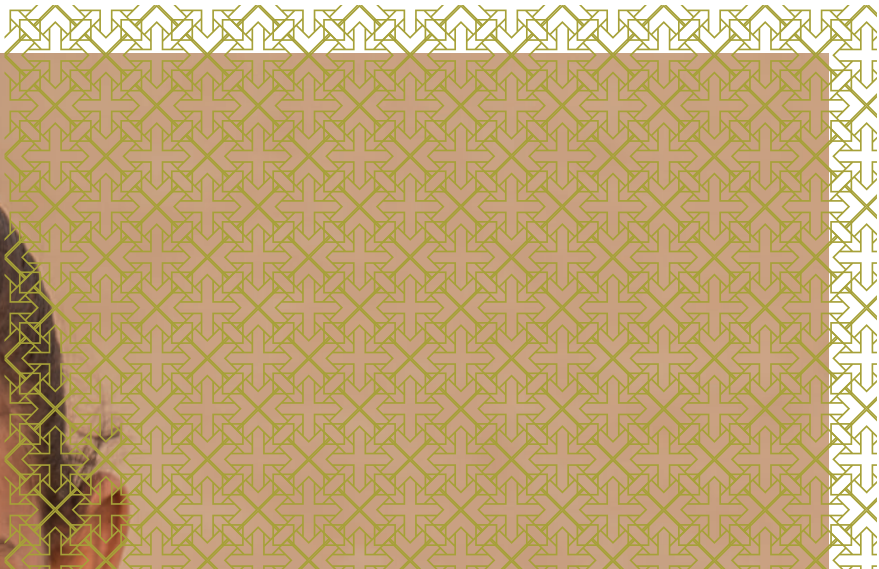


due to the collapsed system. Similar outcomes have been observed in other conflicts whereby male education was impacted to a relatively larger degree than females.<sup>86</sup> If the conflict extends through 2030, it is projected that Yemen's average educational attainment would be 3.9 years—the third lowest in the world.

By focusing on conflict-attributable impacts, the report finds that the conflict has drastically increased income inequality and further worsened gender development inequalities. Moreover, it has decimated education and health systems and made achieving SDG 10 target indicators virtually impossible.

**TABLE 9 | Inequality measures in a No Conflict scenario, in a scenario with conflict, and the conflict-attributable difference between the two.**

	Inequality in a No Conflict scenario				Inequality in a Conflict scenario				Conflict-attributable difference			
	2014	2019	2022	2030	2014	2019	2022	2030	2014	2019	2022	2030
Gini	0.37	0.38	0.38	0.37	0.37	0.6	0.62	0.66		0.22	0.24	0.29
GDI	0.66	0.71	0.73	0.79	0.66	0.62	0.61	0.61		0.09	0.12	0.19
Median consumption (USD/day)	3.25	3.33	3.66	4.96	3.25	1.39	1.11	0.64		-1.94	-2.55	-4.32
Growth rate of 50 <sup>th</sup> percentile consumption		2.1	3.7	3.8		-13.1	-8.3	-7.2		-15.3	-11.9	-11.0
Growth rate of 20 <sup>th</sup> percentile consumption		2.6	3.4	4.2		-19.4	-10.9	-8.3		-22.0	-14.3	-12.5
Difference in growth rate of 20th and 50th percentile consumption		0.5	-0.3	0.4		-6.3	-2.6	-1.1		-6.7	-2.3	-1.5
Growth rate of GDP per capita at PPP		2.3	2.9	4.7		-5.0	-5.1	-3.8		-7.3	-8.0	-8.5
Ratio of average educational attainment (years), population aged 15+	0.67	0.71	0.73	0.79	0.67	0.70	0.70	0.69		-0.01	-0.03	-0.09



DEVELOPMENT  
PATHWAY  
SCENARIOS





## Introduction

This report has thus far focused on analyzing conflict and development in Yemen across four distinct SDGs, but SDGs nor development systems are independent. Development systems are overlapping and interacting—changes in one variable have direct and indirect effects that impact other systems and variables. For example, where food is scarce, increasing its availability should reduce hunger. But if people also lack access to safe water and sanitation, increased food in the face of disease can mean little.

These interactions are often described in terms of synergies where pursuit or achievement of one SDG supports the pursuit or achievement of another and tradeoffs where pursuit or achievement of one SDG may interfere with or undermine the pursuit or achievement of another. Because the SDGs are “integrated and indivisible” and meant to be pursued collectively, it is especially important to understand the synergies and tradeoffs among them.

Research into the relationships between SDGs has generally found more synergies than tradeoffs.<sup>87</sup> Among the SDGs in this report, *SDG 1: No Poverty* and *SDG 2: Zero Hunger* are particularly interactive and synergistic.<sup>88</sup> For example, the alleviation of poverty means that families can afford to buy more and higher-quality food, reducing malnutrition. And growth in agriculture is more effective at poverty reduction than growth in any other sector.<sup>89</sup> In cases of extreme hunger, such as in Yemen, food price inflation and the effort required to stave off starvation and care for malnourished and ill dependents can prevent families from rising out of poverty.

Reducing income inequality—if done by improving the situation of those in most need—is directly linked to reducing poverty and hunger. But the synergies with *SDG 8: Decent Work and Economic Growth* and *SDG 10: Reduced Inequalities* is more complex. Economic growth alone does not necessarily guarantee more rapid alleviation of poverty and hunger, and it could even be associated with greater inequality. However, quality employment and inclusive growth together would make it easier to pursue all three.

Understanding development pathways and the way variables interact is crucial to addressing development

in the real world. A “development pathway” is a set of interconnected variables where one interacts with another, including synergies and tradeoffs.

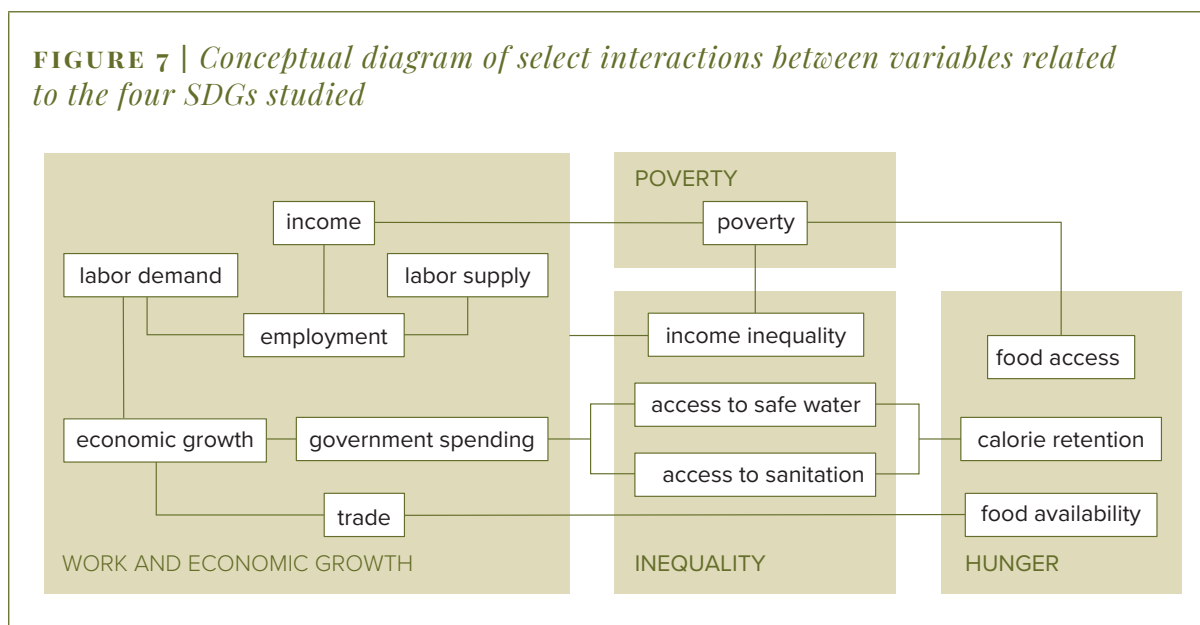
The IFs system is unique in that it brings together all these systems in an integrated way, and in Figure 7 development pathways can be constructed by tracing through the lines in the diagram. It outlines some of the important interactions between the four SDGs studied in this report.

The map is not comprehensive and only focuses on some of the most direct relationships in the development systems analyzed within the report. For example, trade can boost economic growth. A boost in growth will increase labor demand which will equal labor supply, leading to increased employment. With higher levels of employment, households will have more income, reducing poverty. Higher incomes and lower poverty levels mean that families can buy more food, reducing hunger.

The rest of this report focuses on alternative scenarios that reflect different interventions into development pathways in a conflict-affected context. In each scenario, changes are made to one or two development-related variables—increasing the availability of food, for instance—and traced through development pathways to understand the impact of that intervention and how it affects the conflict’s damage.

The scenarios analyzed in this section are outlined in Table 10. They include: (a) increasing household consumption; (b) increasing food availability; (c) improving access to water and sanitation; and, (d) reducing malnutrition. These are compared to scenarios in which conflict continues without the interventions (*Conflict 2030*, assessed throughout this report) and a scenario in which conflict ends in 2019 (*Conflict Ends 2019*).

**FIGURE 7 |** *Conceptual diagram of select interactions between variables related to the four SDGs studied*



**TABLE 10 |** *Description of alternative scenarios used in this section of the report*

Scenario Name	Scenario Description
<b>Conflict 2030</b>	Conflict in Yemen continues through 2030 in order to evaluate the developmental impacts of prolonged fighting.
<b>Household Consumption</b>	Increasing household consumption to 2014 levels reflecting the spirit (though not the magnitude) of current cash-transfer programmes operating in Yemen.
<b>Food Distribution</b>	Relaxing constraints on caloric availability reflecting food distribution, whether food that already exists in warehouses could be distributed or improvements could be made in food imports.
<b>Water and Sanitation</b>	Returning improved access to water and sanitation to 2014 levels, reflecting a possible development intervention.
<b>Targeting Child Malnutrition</b>	Ameliorating the largest impacts of child undernutrition and severe acute malnutrition reflecting targeted policy interventions.
<b>Conflict Ends 2019</b>	Conflict in Yemen ends in the year 2019. This scenario is projected to 2030 to examine the positive effects of ending the conflict. It does not include projections of significant levels of post-conflict foreign assistance. This is the ending conflict scenario analyzed throughout this report.

Each development scenario changes variables that could reflect specific policies, and many organizations are already doing important work in these areas. However, the outlined scenarios are not meant to reflect real-world interventions as the magnitude of simulated interventions are much larger than what appears to be possible.

Throughout this report, in part, the *conflict-attributable* impact on development has been explored. As

discussed in Section 2 (see Figure 4) when comparing the *No Conflict* scenario with the *Conflict 2030* scenario the targeted impact of war on development can be captured. That analysis is continued below and focuses upon how different *developmental pathways* change the conflict-attributable burden of war on development.

Table 11 shows how the conflict-attributable impact on development changes across multiple scenario interventions.

**TABLE 11 | Conflict-attributable outcomes across alternative scenarios**

Conflict-attributable development outcomes across alternative scenarios								
Scenario	Year	Poverty, USD 1.90 (percentage points)	Poverty, USD 3.10 (percentage points)	Malnourished children (percentage points)	Malnourished population (percentage points)	Reduction in average life expectancy (years)	Indirect conflict mortality (deaths, cumulative)	Child mortality (deaths, cumulative)
Conflict 2030	2014							
	2019	39.6	29.1	13.9	16.6	4.3	131,100	140,750
	2022	49.4	38.7	23.8	30.8	5.5	315,600	331,200
	2030	71.0	63.4	54.9	83.8	9.9	1,481,100	1,496,200
Household Consumption	2014							
	2019	39.6	29.1	13.9	16.6	4.3	131,100	140,750
	2022	19.9	20.4	16.3	23.1	5.5	286,800	304,500
	2030	37.3	43.7	38.7	47.2	8.6	1,106,800	1,169,300
Food Distribution	2014							
	2019	39.6	29.1	13.9	16.6	4.3	131,100	140,750
	2022	47.0	36.7	10.4	19.9	5.5	271,200	283,300
	2030	62.0	57.4	34.0	30.3	8.2	1,011,200	1,052,600
Water and Sanitation	2014							
	2019	39.6	29.1	13.9	16.6	4.3	131,100	140,750
	2022	49.4	38.7	23.0	30.9	5.3	308,500	324,400
	2030	71.1	63.5	33.1	82.6	7.1	1,226,600	1,243,700
Targeting Child Malnutrition	2014							
	2019	39.6	29.1	13.9	16.6	4.3	131,100	140,730
	2022	49.4	38.7	9.8	30.8	4.5	270,100	285,700
	2030	70.9	63.5	20.7	80.8	6.2	1,012,600	1,027,000
Conflict Ends 2019	2014							
	2019	39.6	29.1	13.9	16.6	4.3	131,000	140,750
	2022	22.2	24.4	7.1	12.4	2.3	218,950	227,150
	2030	25.7	35	9.8	10.9	1.9	402,750	470,650

## Increasing Household Consumption

Conflict not only harms an economy, it also destroys many household coping mechanisms for dealing with economic shock.<sup>90</sup> Household earning capacity is stifled as members are killed, disabled and/or recruited into fighting. Families may drain their savings to make up for lost income or to care for injured and ill members. Assets are destroyed by warfare or abandoned as families are forced to flee. Employment markets are disrupted, making it harder to find decent work while prices for food staples increase and more money is needed to survive. Conflict also often fractures social networks with households no longer able to rely on community and family support networks.

In Yemen, the escalation of war in 2015 drastically reduced levels of household consumption. In only one year, Yemen annual household consumption fell from an estimated USD 29 billion (USD 1,100 per capita) in 2014 to USD 21 billion (USD 800 per capita) in 2015. If the conflict persists, this report projects consumption will be halved from 2015 levels—falling below USD 15 billion (USD 400 per capita) in 2030.

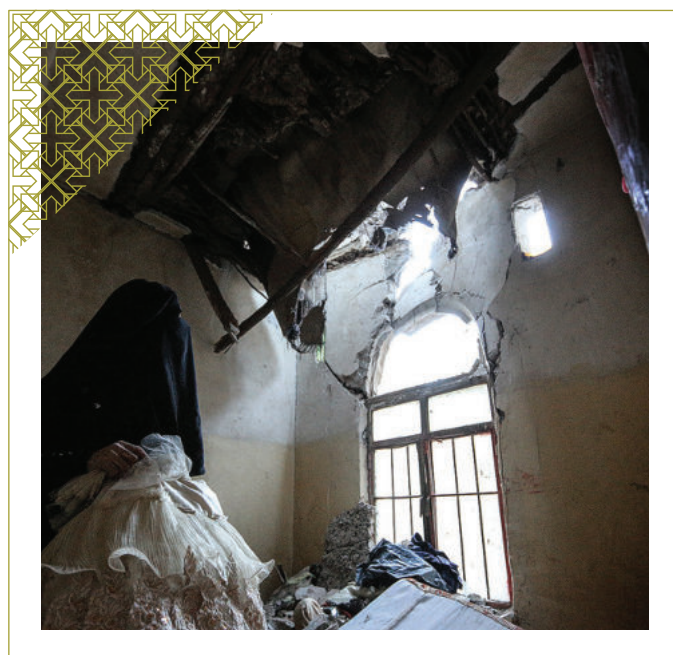
Under such severe financial constraints, many Yemeni households cannot afford to meet their basic needs. This scenario focuses on directly easing those constraints by simulating an increase in household consumption during ongoing conflict. In 2020, this would raise the household consumption back to USD 29 billion—an increase of USD 7.5 billion as compared to the *Conflict 2030* scenario.

The Yemeni household consumption could be supplemented in several ways: direct cash transfer programmes; improved employment opportunities; and, increased remittances. Many programmes are already in place and carrying out valuable work in these areas.<sup>91</sup> However, each of these specific policy interventions has benefits and drawbacks that require careful consideration. For instance, a massive direct cash transfer programme, the most direct way to raise incomes, has the potential to exacerbate inflationary pressures and thus undercut its own effectiveness.<sup>92</sup> Rather than describing a specific policy strategy, this scenario simulates the successful implementation of an ambitious policy agenda aimed at increasing household consumption during conflict.

Growing household consumption power has a significant and direct impact on reducing poverty. By 2022, despite ongoing conflict, this scenario leads to 9.4 million fewer Yemenis in extreme poverty and 5.9 million fewer in poverty compared to the *Conflict 2030* scenario—essentially cutting the conflict's impact on poverty in half. With more money, households can afford to buy more and higher-quality food which will reduce childhood malnutrition by 16.2 per cent relative to the *Conflict 2030* scenario.

Since 2015, malnutrition has been a leading cause of conflict-attributable deaths in Yemen, mostly suffered by children. Malnutrition and communicable disease influence one another in a vicious cycle: malnutrition makes communicable diseases more deadly by compromising immune systems and increasing susceptibility to infection, while communicable diseases undermine a body's ability to absorb essential nutrients.<sup>93</sup> Thus, this scenario prevents 28,800 deaths by 2022 and 374,500 by 2030.

The erosion of purchasing power in Yemen is the greatest contributor to the extreme hunger many Yemenis are facing.<sup>94</sup> A significant increase in household consumption will lift millions out of poverty and save hundreds of thousands of lives. However, the simulated impact will be undermined as long as conflict continues, the food supply in many communities remains a challenge, and poor infrastructure and living conditions foster and facilitate the spread of disease.



## Improving Food Distribution & Caloric Availability

Another reason for high levels of malnourishment in Yemen is the lack of food availability. Over the past few decades, Yemen has become highly dependent on imports for food. Since 2015, the conflict has affected food availability by further lowering domestic food production, limiting food imports and impeding the distribution of food already in the country.

Average caloric availability in Yemen has already fallen considerably. It is estimated that if the conflict continues through 2019, caloric availability will be reduced by 20 per cent—from an estimated 2,260 calories per capita in 2014 to 1,800 calories per capita in 2019, the lowest in the world. Only a handful of countries historically have experienced such low average levels of caloric availability, the latest being Haiti in 2005.

This scenario simulates an increase in the available calories in Yemen by raising food imports and improving food distribution, both through increased availability and a corresponding drop in food prices. The calorie increase could occur as a combination of direct food aid as well as improved food import and distribution. A major constraint faced by food importers, for example, is a lack of access to foreign exchange which is complicated as Yemen's Central Bank is currently

divided between Sana'a and Aden.<sup>95</sup> Strengthening and restoring Yemen's banking sector could address these challenges and support increased food imports.<sup>96</sup>

Increasing caloric availability improves undernutrition. If the conflict continues, 48.2 per cent of adults and 57.3 per cent of children are projected to be malnourished by 2022. But improvements in caloric availability, as simulated here, lower malnutrition in the total population by 10.9 percentage points and in children by 13.5 percentage points. This scenario reduces the impact of the conflict on malnutrition overall by a third and in children by half. As a result, it prevents the deaths of 44,800 by 2022 and 471,800 by 2030.

Studies have shown that in many contexts, directly providing food can be more effective than cash transfers at improving food security because: (a) it ensures that the food reaches the populations in need and (b) because cash transfers may not be responsive to fluctuation in food prices.<sup>97</sup> During conflict, this is especially likely to be true as markets and distribution networks are disrupted, potentially resulting in the food supply not being responsive to demand. In Yemen's conflict, port blockades and functional limitations—as well as foreign currency shortages—have limited food imports.

In this scenario, the study found that directly increasing caloric availability has a greater impact on reducing malnutrition and the conflict's indirect death toll than increasing household consumption. It is projected that this approach could save nearly 100,000 additional lives over the next decade.

However, increasing food availability alone has little impact on poverty alleviation in the *Conflict 2030* scenario, reducing it by just 6.1 percentage points by 2030. Increasing caloric supply is important for improving development and preserving human capital while the conflict is ongoing. It is also crucial for sustaining and saving the lives of Yemeni children. But it does not immediately address the problem of low purchasing power as households will still be faced with severely constrained incomes and limited economic opportunities, and poor living conditions and infrastructure continue to foster disease.





## Improving Access to Water & Sanitation

In Yemen, access to safe water and improved sanitation has deteriorated significantly during the conflict, with rural areas and the internally displaced hit especially hard.<sup>98</sup> Reduced access can be attributed—in part—to overcrowding of displaced populations and attacks on crucial water infrastructure.<sup>99</sup>

Poor water and sanitation conditions are especially detrimental to Yemenis' health as they can cause infectious diseases, lower immunity and interfere with the absorption of nutrients.<sup>100</sup> In 2014, only 42 per cent of the population had access to piped water and 38 per cent lacked access to improved sanitation. In 2019, this report estimates that 19 per cent of the population lacks access to clean water and 42 per cent lacks access to safe sanitation. And in many districts, the figures are much worse.<sup>101</sup>

These conditions have worsened malnutrition and communicable diseases in Yemen and led to the largest cholera outbreak in epidemiologically-recorded history,<sup>102</sup> with over 1.3 million suspected cases and over 2,600 associated deaths since the April 2017 outbreak.<sup>103</sup> In addition to dire health consequences, the long travel times many Yemenis must endure to collect water have exposed women to harassment and forced children to drop out of school.<sup>104</sup>

This scenario addresses the problem of water and sanitation infrastructure by restoring access to 2014 levels. The water and sanitation improvements modeled in this report have an immediate effect on deaths from

communicable, especially diarrheal, disease. Mortality from diarrheal disease is cut by nine per cent by 2022 and 38.3 per cent by 2030, relative to the *Conflict 2030* scenario, saving 118,000 additional lives.

Water and sanitation improvements do not have a very large impact on adult and child malnutrition through 2022 because food access challenges remain unsolved. By 2022, the scenario leads to a reduction in child malnutrition of 1.6 percentage points relative to the *Conflict 2030* scenario. But by 2030, even without changes to food supply and prices, child malnutrition falls to 72.6 per cent of what would be expected in a conflict situation. Improving water and sanitation conditions over time mitigates the harmful interaction between undernutrition and infection. As a result, this scenario saves the lives of 7,200 by 2022 and 255,000 by 2030.

Unsafe water and sanitation conditions foster the spread of infectious diseases, leading to malnourishment, illness and death among young children. Expanding access to water and sanitation infrastructure has an immediate and significant impact on child malnourishment and deaths from diarrheal disease. And water and sanitation improvements complement raising household consumption or increasing the supply of calories, ensuring that greater access to food is not undermined by illness. However, through improving water and sanitation alone, the reduction in indirect deaths is not as great as in the other three analyzed *Developmental Pathways* scenarios. Additionally, it also has little impact on other areas like reducing poverty. Moreover, as long as the conflict continues, progress will be weakened by the physical destruction of infrastructure and displacement of populations into poor living conditions.

## Targeting Child Malnutrition

Malnutrition in Yemen is a major driver of the conflict's massive indirect death toll. The war has exacerbated already troubling levels of malnutrition by reducing incomes, limiting the supply and availability of food, and degrading water and sanitation infrastructure. Addressing these underlying issues is important for sustained improvement in Yemen's health and human capital.

Closely tied to health outcomes, malnutrition is associated with an estimated 45 per cent of deaths for children under five in Yemen.<sup>105</sup> Behind South Sudan, Yemen has the second-highest childhood SAM prevalence globally (9.2 per cent) with roughly 400,000 children under five suffering.<sup>106</sup> Children with SAM are more susceptible to infection, more likely to have severe illnesses,<sup>107</sup> and in Yemen are nine times more likely to die than their healthy peers.<sup>108</sup>

Individuals with severe malnutrition as children are likely to have lifelong consequences such as impaired cognitive development, as well as lower levels of

economic productivity. Additionally, mothers who were malnourished as children are more likely to have reproductive complications and low birthweight children, further impairing another generation.<sup>109</sup>

In most cases, the treatment of SAM requires the identification of affected children and provision of ready-to-use therapeutic foods, while medical complications may necessitate further inpatient treatment.<sup>110</sup>

This scenario addresses some of Yemen's most pressing health risks—particularly SAM and child malnourishment, eliminating the prevalence of SAM and lowering child malnutrition. This type of targeted intervention has a very significant impact on reducing

conflict-attributable indirect mortality. Compared to the *Conflict 2030* scenario, this scenario saves 45,500 lives by 2022 and 468,400 by 2030.

Directly addressing acute malnutrition is highly effective at reducing child deaths in the short term. Rather than broadly improving consumption throughout the country, for instance, this scenario simulates a concerted effort to address a smaller group of Yemen's most vulnerable. This has the strongest immediate impact, saving the lives of children who receive treatment, but would require significant work to identify and treat all cases of SAM, for instance. It also has the limited secondary impacts, such as on poverty.

## Ending the Conflict

The impact of Yemen's conflict on development can be alleviated through improved household consumption, food availability, health systems, and water and sanitation. But while the conflict is ongoing, there is no amount of work that can match the impact of simply ending the conflict through political settlement.

The *Conflict Ends 2019* scenario simulates the impact of the termination of large scale fighting on development if war terminated at the end of 2019. It does not model recovery efforts beyond this and as such the impact may be underestimated.<sup>111</sup>

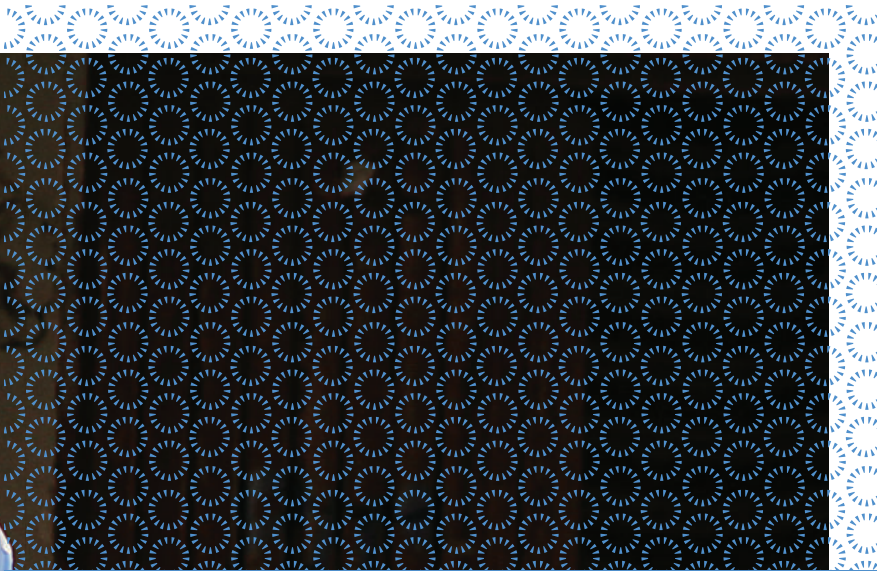
If the conflict ended in 2019:

- ▶ The portion of the population living in poverty would be reduced by 27.2 percentage points by 2022;
- ▶ The conflict-attributable impact on GDP per capita would improve from USD 2,580 to USD 1,870 by 2022;
- ▶ Conflict-attributable child malnutrition would improve from 23.8 per cent to 7.1 per cent by 2022;

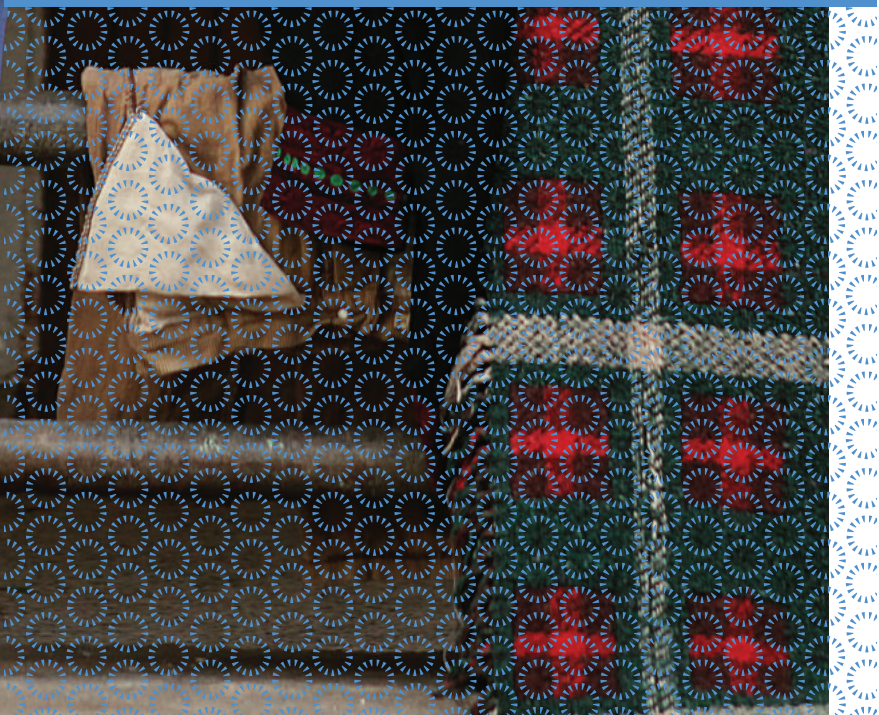
- ▶ Conflict-attributable undernutrition would be reduced in 2022 from 30.8 per cent to 12.4 per cent;
- ▶ Indirect conflict fatalities would reduce by 96,700 by 2022 and 1.09 million by 2030;
- ▶ Conflict-attributable child fatalities would be 104,050 lower in 2022 and 1.03 million lower by 2030;
- ▶ Inequality would also improve from a Gini of 0.66 to 0.42 by 2030.

An end to the conflict would reduce poverty and improve economic performance, leading to increased household consumption and lowering levels of inequality. It would improve the availability of calories through imports and distribution; allow for investments in water and sanitation; and, increase access to health services, reducing the burden of extreme malnutrition.

Ending the conflict would unlock the opportunity for recovery that would improve all the drivers of human development explored in this section. Not only could Yemen recover lost ground, it could once again begin to make progress toward achieving the SDGs.



# CONCLUSION





Even prior to the escalation of armed conflict in Yemen in 2015, the country was facing widespread poverty and food insecurity, a strained economy, and stark inequalities among individuals, by gender, and between regions. Yemen was not projected to meet targets for any of the SDGs analyzed in this report, but in the absence of conflict is likely to have made modest improvements in all four SDG areas.

The escalation of Yemen's conflict in 2015 dramatically altered the country's development trajectory and has already done immense damage. It thrust millions of Yemenis into poverty and hunger. It devastated the country's economy, leaving many without regular work or salaries. And it has made Yemen one of the most unequal countries in the world. The conflict is responsible for the death and suffering of millions of young children, for setting back human development by decades, and for reversing progress toward the SDGs.

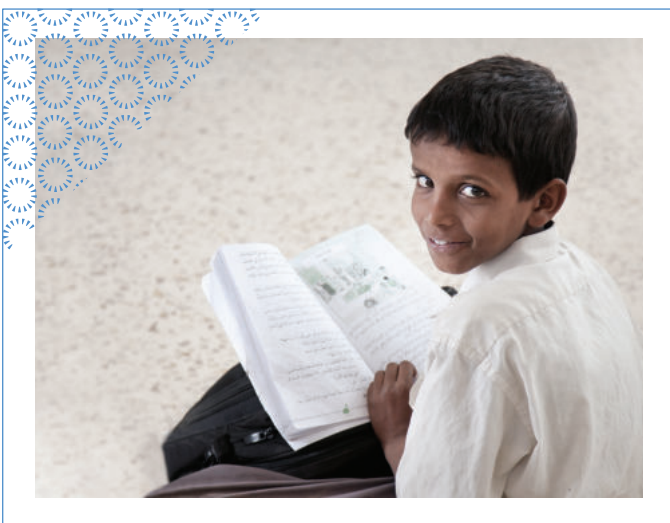
If the war continues, the situation will only deteriorate. If Yemen remains at war through 2030, it is projected that not only will the overwhelming portion of Yemenis live in poverty, the depth of poverty will be the worst in the world. The population overwhelmingly will be malnourished, and many of those who survive will be faced with lifelong developmental stunting, along with the associated impacts on health, education and productivity. The economy will be fundamentally altered, with GDP per capita ranking among the worst six countries globally, hobbling prospects for future recovery. And severe inequality will tear at the social fabric and make Yemen more vulnerable to conflict and unrest in the future.

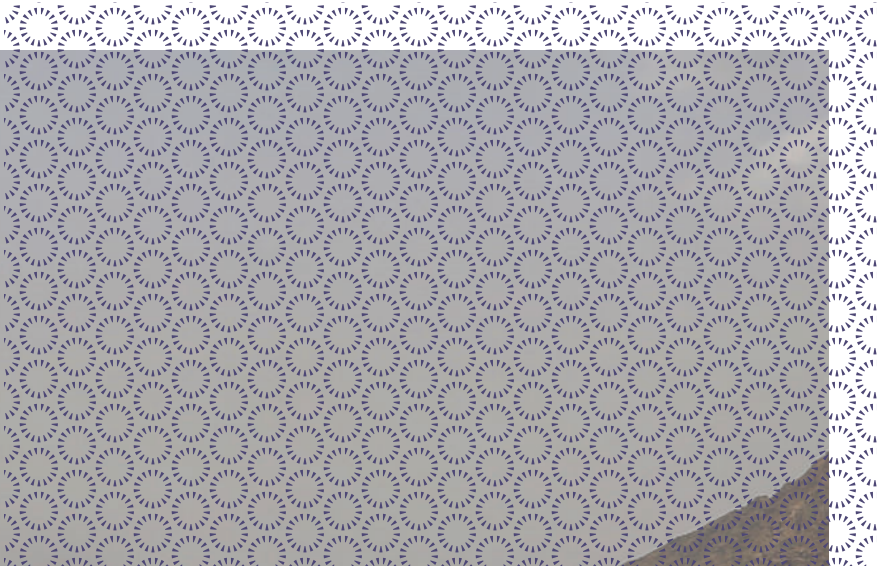
Both conflict and human development take place within interconnected systems—improving one aspect of development has impacts on others. Understanding these development pathways is crucial to assist Yemen and ease the war's suffering. The four scenarios in Section 7 of this report help to illuminate how development could play out in a Yemen in conflict.

The report finds that increasing household consumption in Yemen helps alleviate poverty and reduce malnutrition as families can afford to buy higher quantities and quality of food. Improving the food supply through imports and distribution—although there is limited effect on poverty—reduces hunger more directly. Targeting acute malnutrition has an important and immediate impact, saving the lives of children who are severely undernourished today, but has more limited secondary impacts such as poverty reduction. While improving water and sanitation infrastructure immediately addresses the problem of communicable disease, its greatest impact is in the longer term by slowing the vicious cycle between undernutrition and communicable disease.

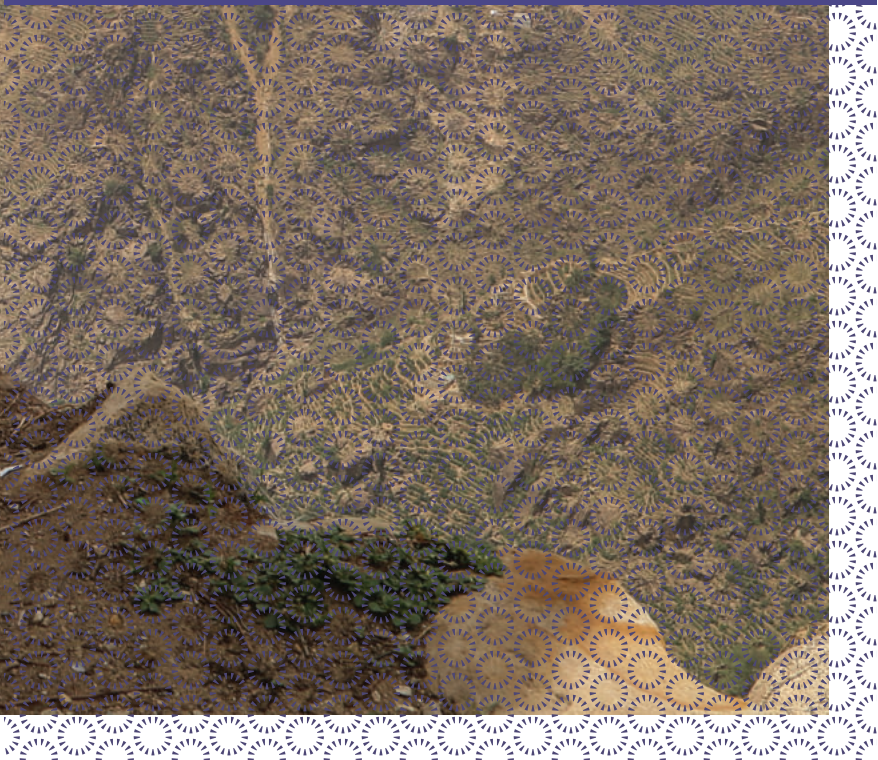
These understandings are important to structuring assistance to Yemen while there is ongoing conflict. As shown in this report, addressing various critical points in development pathways—such as incomes, food availability, malnutrition, and water and sanitation infrastructure—can mitigate the human development impacts of the conflict. Crucially, however, none of the scenarios is sufficient to eliminate the war's suffering.

The conflict is changing Yemen's development system, not just individual measures. As long as it persists, it will continue to hinder Yemen's economy, constrain incomes, interfere with food supply and distribution and deepen inequality. A peaceful end to the conflict is not only the scenario that saves the most lives, it is the only solution that will allow Yemen to start the path toward recovery.





# APPENDIX A: CALIBRATION OF THE IFs MODEL





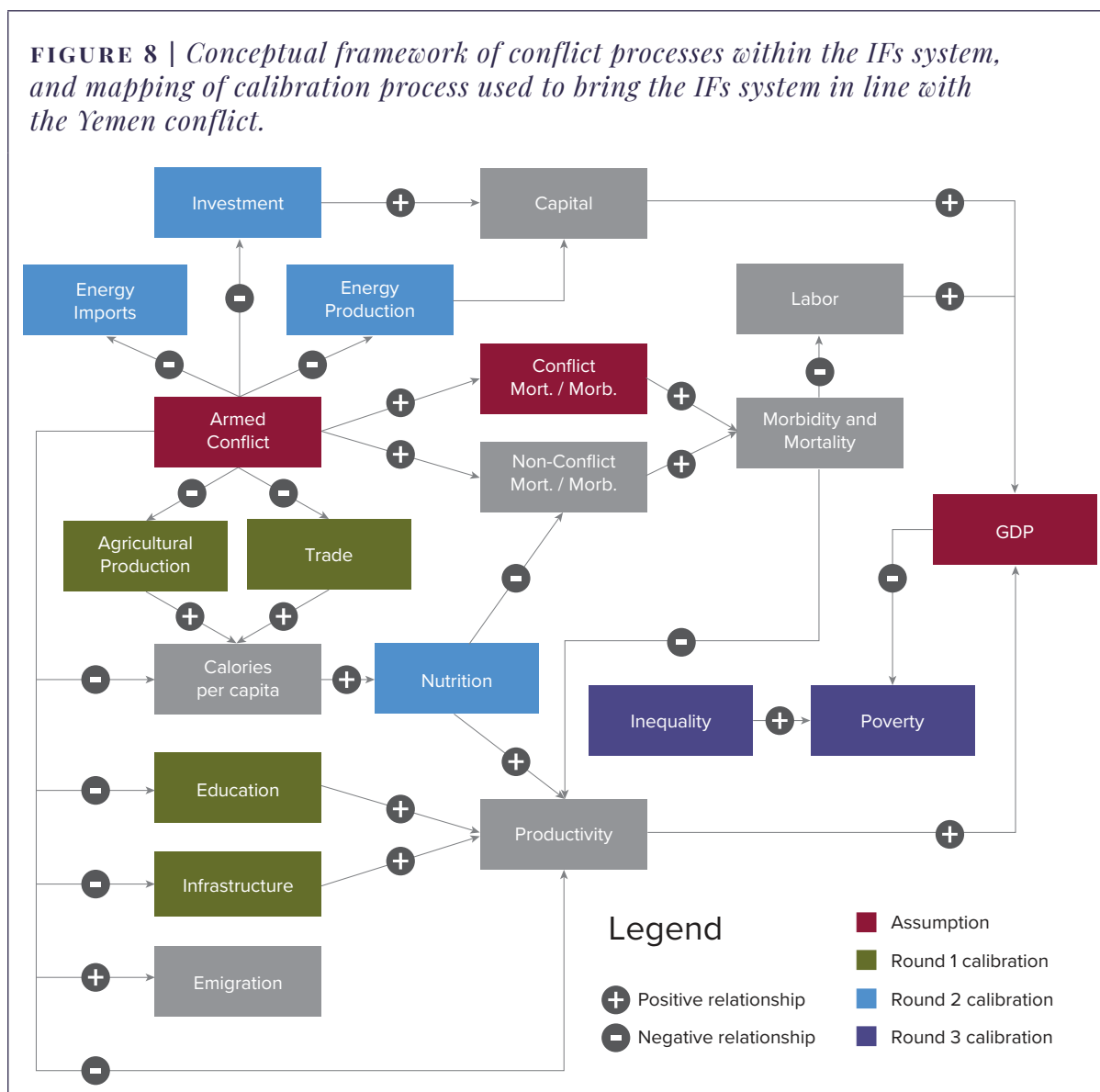
The calibration of the IFs model follows largely from the approach undertaken in the report *Assessing the Impact of War on Development in Yemen*,<sup>112</sup> an earlier report commissioned by the United Nations Development Programme. Because of the difficulties associated with collection and dissemination of accurate data under conflict conditions, the accuracy and quality of data reporting on the conflict in Yemen continues to be a large issue for international actors working on the conflict. In this report, the IFs model was calibrated in successive stages, using data and estimates from a wide body of international and other organizations reporting on or involved in programming around the Yemen conflict.<sup>113</sup>

In order to capture the effects of the conflict in Yemen through today, successive rounds of calibration were undertaken to bring the IFs model in line with the current state of Yemen, beginning with those variables that were most directly and significantly affected by the conflict. This calibration sequence starts with an exogenous determination of the number of direct conflict fatalities, the magnitude of the conflict, and GDP growth rates. Figure 8 outlines the various stages of the IFs model calibration, as well as the variables that were adjusted during each stage.

For the core conflict scenario in this report, the strategy for calibration of all variables past GDP growth, conflict deaths, and conflict magnitude is essentially the same. Data collected was used either as a direct input or a benchmarking target (depending on quality of data and range of values reported for a given variable in a given year) in order to inform the parameterization of different variables within the IFs system framework for the years during which this phase of the conflict was occurring (2015-2019, where later years of data were available). The model was run iteratively in various



**FIGURE 8 |** *Conceptual framework of conflict processes within the IFs system, and mapping of calibration process used to bring the IFs system in line with the Yemen conflict.*



calibration rounds in order to ensure that the period past the base year (2015) represents, to a sufficient extent, the conditions on-the-ground as they have developed in Yemen over the last four years of conflict. The parameterization of these variables was then held constant or extended out over the various conflict horizons examined across the two reports (2019, 2022, 2030).

In order to examine the effect of potential conflict termination after 2019 in the *Ending Conflict 2019* scenario, these parameter adjustments are relaxed back to model base run values for the remainder of the projection horizon. In the *No Conflict* scenario, the base run of the model is preserved, save for parametric

adjustments that diminish the probability of conflict onset and societal violence.

For a more thorough discussion of the assumptions around the calibration of specific system variables, interested readers may refer to Annex B of “Assessing the Impact of War on Development in Yemen”.<sup>114</sup>

GDP growth, conflict death and magnitude assumptions for projection years (2019-2030) are borrowed from the first report in this series in order to maintain consistency and comparability of findings across studies.<sup>115</sup> GDP growth values are taken from data and partial projections from the United Nations Department of Economic and Social Affairs,<sup>116</sup> and extended for

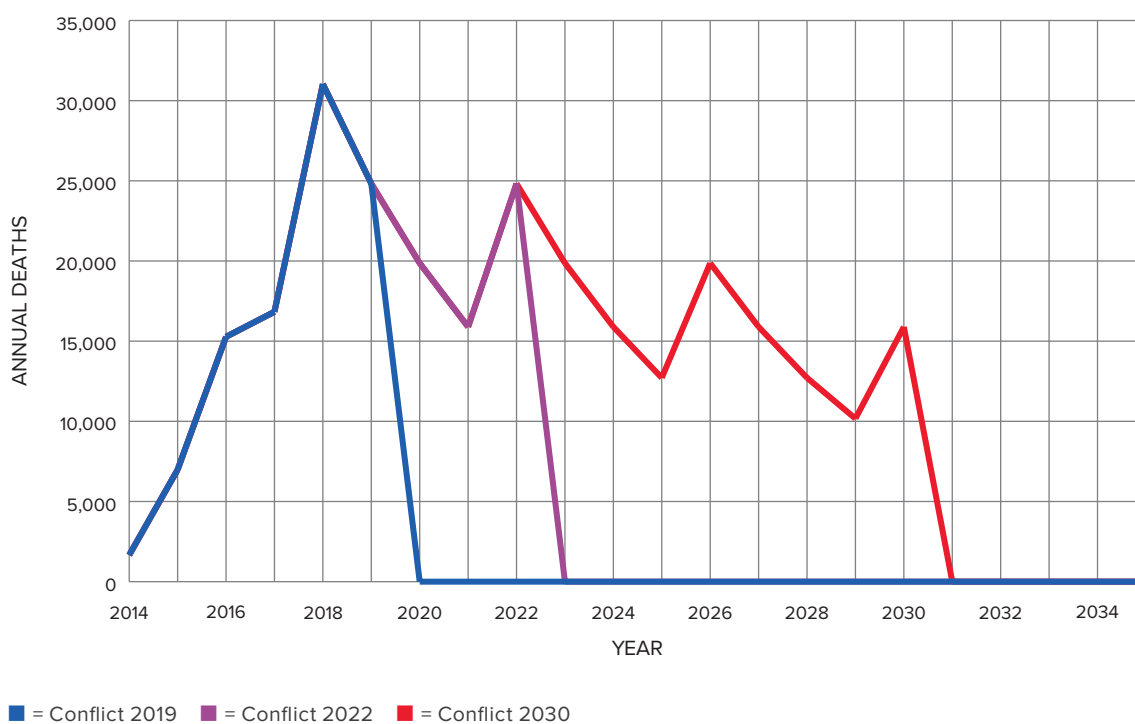
scenario analysis with a growth form that asymptotically approaches zero over the full conflict horizon and remains at an average of -2.3 over the conflict horizon in the 2030 conflict termination scenario. It was elected to not model any years reflecting positive growth figures during conflict years. While there are historical examples of economic growth under conflict, the dynamics of growth under conflict are very unclear.<sup>117</sup>

Conflict death values are taken from the Armed Conflict Location and Event Data project (ACLED), for the years 2016-2018, while values from the Institute for Health Metrics and Evaluation are used for the year 2015. For future projection years, three “flare-ups” are modeled over the longer-term scenario horizon (conflict termination in 2030). This assumption tracks conceptually with the year-on-year volatility often seen

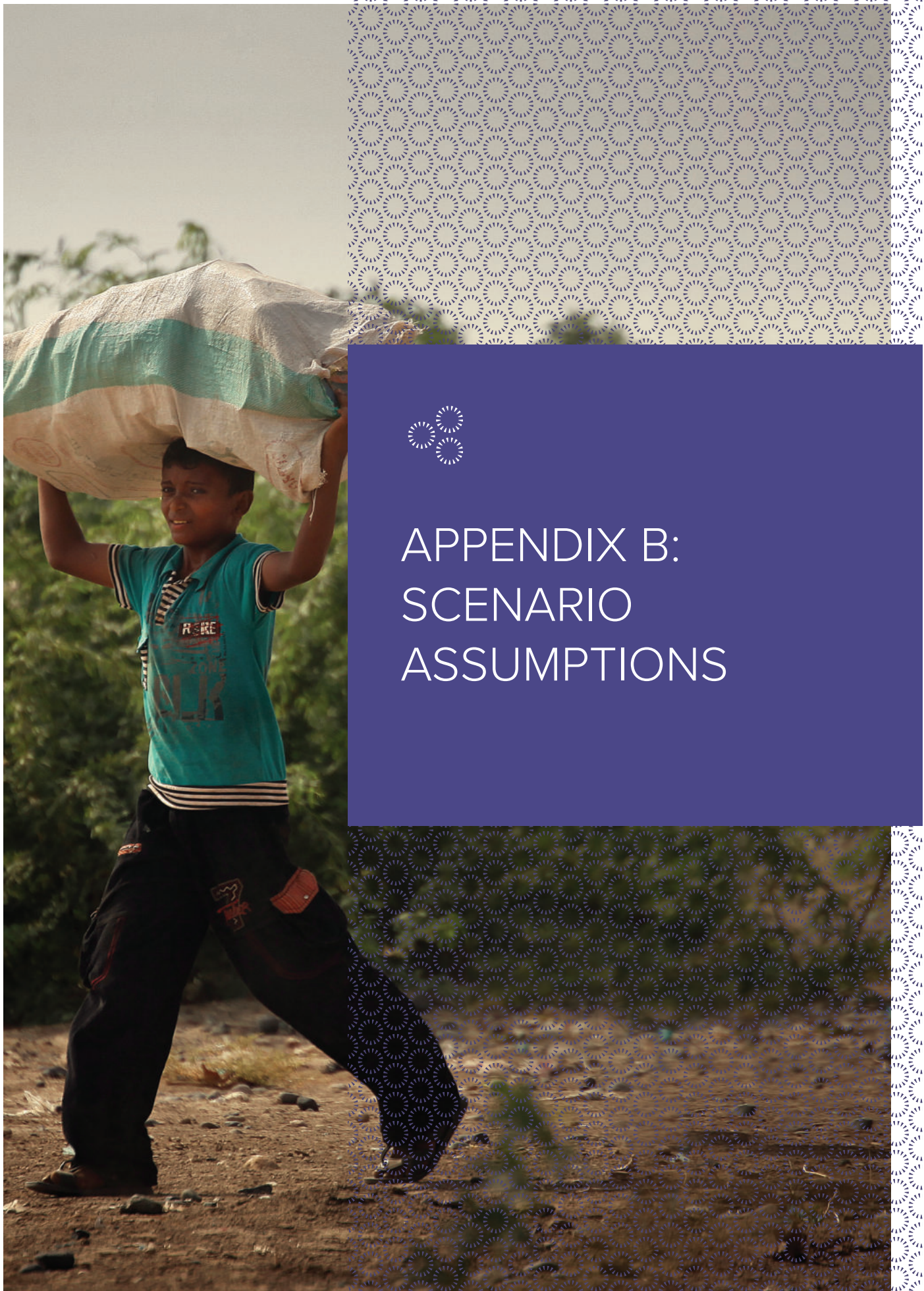
in long-term conflicts, but is simulated with a parameterized decay in magnitude combined with periodic flare-ups every four years, with a successive decay in magnitude for each flare-up over time (See Figure 9).

It is noted that the ACLED project has, as of June 18<sup>th</sup>, 2019, released estimated conflict death numbers for the year 2015 that total approximately 17,100.<sup>118</sup> This count exceeds the 2015 data used in the calibration of the IFs model by approximately 8,000 conflict deaths. The new data from ACLED was not available during the calibration of the IFs model, and thus the results from this study may potentially underestimate the full extent of the impact of conflict on development in Yemen.

**FIGURE 9 | Conflict magnitude assumptions, adapted from Moyer et al. (2019). This report keeps the conflict assumptions from Moyer et al. in place in order to maintain continuity of analysis and findings.**







## APPENDIX B: SCENARIO ASSUMPTIONS



For this report, the *Conflict 2030* scenario, as well as the *No Conflict* scenario, that were created for the report *Assessing the Impact of War on Development in Yemen* were maintained.

A total of four alternative *development pathway* scenarios were modeled for the purposes of this report, in order to explore pathways of development in Yemen under conflict conditions. The scenarios and their

narratives are described in Table 12 below. Along with these four, an additional scenario (*Conflict Ends 2019*) was added to model the impact of ending conflict on development.

Development Pathways	
<b>Household Consumption</b>	Households have increased purchasing power, leading to a 150-calorie per capita increase in food consumption in 2020 (sustained through 2030).
<b>Food Distribution</b>	Food is more effectively imported into and distributed throughout the country, enabling communities in need to access food aid and other agricultural products that they are currently not able to access.
<b>Water and Sanitation</b>	Access to improved water and sanitation infrastructure return to 2014 levels. Water and sanitation access in Yemen has been severely degraded by the conflict and has, in part, driven a large cholera outbreak.
<b>Targeting Child Malnutrition</b>	Malnutrition, especially SAM among children, is targeted directly. SAM and malnutrition drop to 2014 levels and remain constant (proportional to the child population) through 2030.

These developmental pathways each have a set of scenario interventions which were modeled on top of the set of interventions which forms the *Conflict 2030* scenario. For these developmental pathways, all scenario interventions are modeled starting in the year

2019 and extend through the conflict horizon (2030) in order to simulate policy-relevant interventions that are thematically similar to what could be undertaken in Yemen today.

## Household Consumption

This scenario explores the impact of significantly increasing incomes and thus household consumption under conflict conditions in the Yemen context.

1. An intervention was made on the aggregate consumption term for Yemen in the model, raising consumption in the subsequent year (2020) to 2014 levels, and holding this level of consumption constant across the conflict horizon.

2. An intervention was made on the calories per capita term that results in an increase in average caloric intake of roughly 150 kcal/day relative to the *Conflict 2030* value in 2020. This value was benchmarked via examination of reporting from various cash transfer and cash-for-food programmes that have been undertaken in Yemen, from organizations like the World Food Programme<sup>119</sup> and the International Food Policy Research Institute.<sup>120</sup>

## Food Distribution

This scenario explores the impact of lowering some of the barriers to food import and distribution. The *Conflict 2030* scenario is adjusted by relaxing the agricultural trade term which was introduced in the *Conflict 2030* scenario to bring agricultural imports to levels reported by FAO's Global Information and Early Warning System<sup>121</sup> and the World Bank.<sup>122</sup> Because food imports changes the average caloric term, this intervention simulates both an increase in agricultural imports, which could be thought of as food aid or bought goods, as well as an increase in the distributional efficiency of the calories imported.



## Water & Sanitation

This scenario explores the impact of increasing access to water and sanitation. The *Conflict 2030* scenario is adjusted so that the portion of the population with access to unimproved water sources returns to 2014 values by 2020, and the portion of the population with access to piped water infrastructure follows the same pattern. Sanitation is adjusted in the same manner



## Targeting Child Malnutrition

This scenario explores the impact of a policy that reduces child suffering in the most vulnerable portions of the child population through interventions that reduce undernutrition. Here, the rates of child malnutrition and severe acute malnutrition in children under 5 are adjusted to 2014 levels by 2020.





# APPENDIX C: MULTIFACTOR PRODUCTIVITY IN THE IF<sub>s</sub> SYSTEM



The Economics model of the IFs system is a hybrid, quasi-computable general equilibrium-type model that incorporates a social accounting matrix, an agent-class representation of a goods and services market, as well as an endogenous representation of productivity.<sup>123</sup> IFs uses a modified Cobb-Douglas production function, a common functional form in economics modeling which provides a representation, most basically, of the productivity of capital and labor, as well as a residual term which represents technological growth.

The Cobb-Douglas production function in IFs is expanded in a few key ways, in order to more accurately and flexibly model the numerous components which contribute to the growth of productivity. This expansion follows largely from analysis from scholars such as Barro and Sala-i-Martin,<sup>124</sup> who have conducted research ‘unpacking’ the technological growth term (also referred to as the “Solow residual”) of the Cobb-Douglas production function.

IFs thus provides a user-controllable representation of multifactor productivity (MFP), which is a decomposition of a total factor productivity (TFP) term, which represents technological growth across four types of ‘capital’—human capital, social capital, physical capital, and knowledge capital. Human capital describes the

returns to growth that result from such advances as improved educational attainment and spending, improved health conditions and longevity, among others. Social capital represents the growth contribution from improvement in business environment and environments for other economic activities, as well as improvements in the ‘rule of law’ (broadly constituted), among others. The physical capital term refers to the growth contribution from spending on infrastructural improvement, while the knowledge capital term refers to the growth contribution from activities such as investments in R&D, technological diffusion resulting from increased integration in trade networks, and the stock of people with educational training in STEM professions.<sup>125</sup>





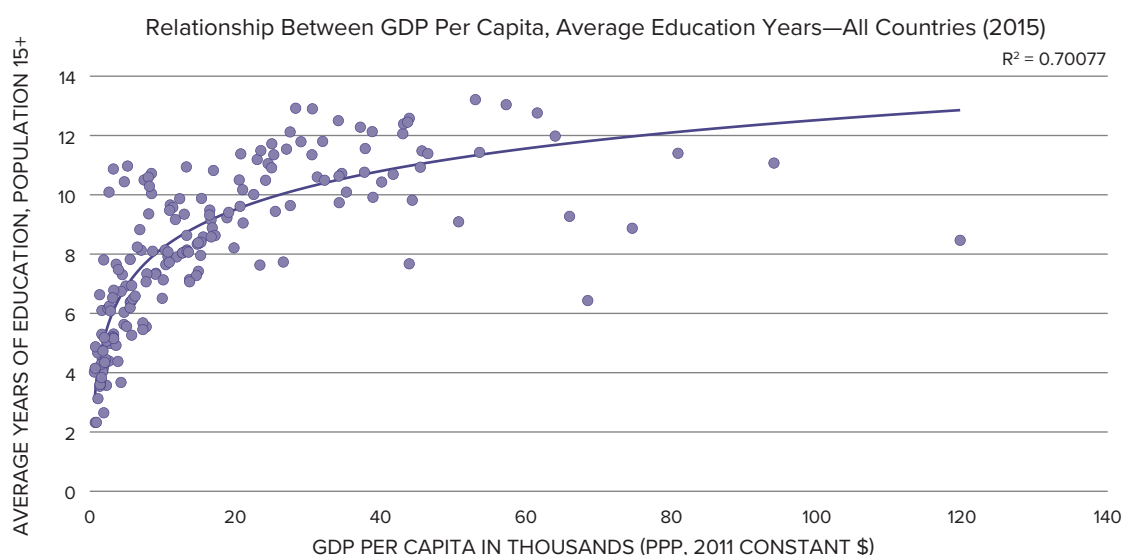
These four capital terms either contribute to a country's aggregate TFP based on the computed value of their respective component terms in a given time-step compared to the expected value of these terms in a given time-step, the latter of which is generally produced by a functional form which relates the capital term in question to a significant global structural driver, such as GDP per capita, across all countries. If a projected value for a variable within a given MFP term falls below its expected value (the value returned by the functional form used to compute the cross-country relationship) this will feed forward functionally through the MFP term in question as a 'drag' on productivity for that particular term. MFP terms are further subject to a global convergence factor which simulates a base annual technological growth value depending on the relational context of a given country relative to the rest of the world.

This representation of MFP in IFs effectively endogenizes productivity within the system (making

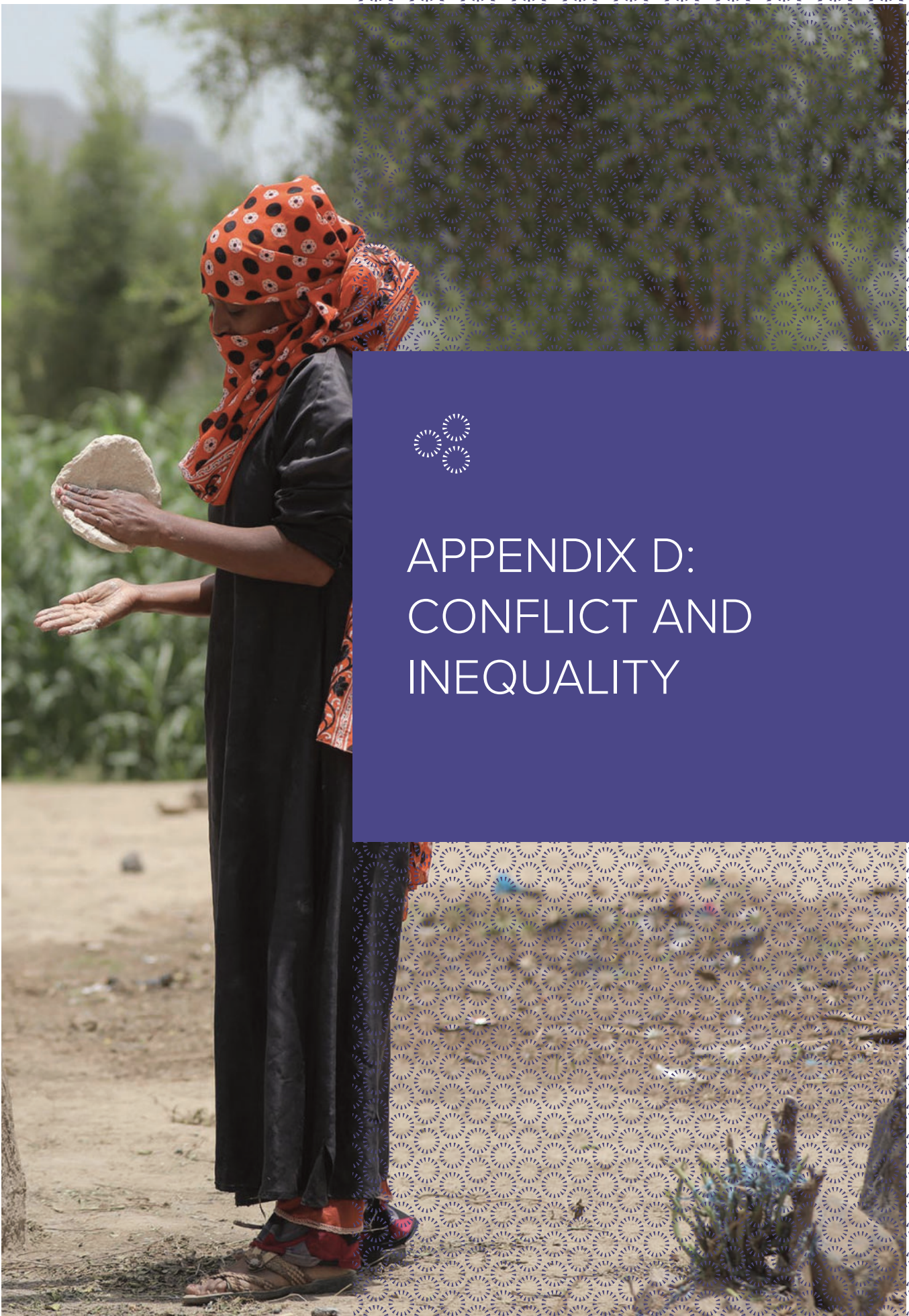
the productivity terms themselves responsive to other variables within the system) as well as affords wider flexibility in scenario analysis for users interested in interventions conceptually related to growth decomposition, or the effects of changes in other dimensions of human systems on technological productivity. The results contained in Table 7 of the main report can thus be interpreted as the percentage point net contribution of the variables representing a given technological growth factor (human capital, knowledge capital, etc.) to overall economic growth. Negative values can here be conceptualized as the factor in question being a 'drag' on economic productivity, while positive values indicate that the factor in question provides a 'boost' to productivity.

Interested readers may find more information about the representation of MFP in IFs, as well as the Economic model of IFs in general, through the published works of Barry B. Hughes.<sup>126</sup>

**FIGURE 10 | Illustration of MFP component contribution to growth estimation. Points represent individual countries for the year 2015. For those countries with points above the regression line ( $r=0.70$ ), a contribution to the MFP Human Capital Index will be registered, while countries below the regression line will receive a growth "penalty" for MFP Human Capital Index contribution for this particular year.**







## APPENDIX D: CONFLICT AND INEQUALITY



While there exists a significant body of research regarding the role of inequality as a contributing factor to intrastate conflict, few empirical studies have explored the relationship in the reverse direction. Some potential reasons for this include the lack of extensive historical inequality data that cover countries during periods of conflict, as well as methodological barriers for the applicability of some historical Gini data to conflict studies.<sup>127</sup> In this study, an increase in the Gini index<sup>128</sup> was reported since conflict onset in Yemen that is striking in both its absolute magnitude as well as its rate of growth, with a total increase of around 23 points over a 5-year conflict horizon (2014–2019), or an average of about 4.6 points per year (Figure 11).

Here an overview of the available data and literature was provided considering this report's findings regarding income inequality. It finds that, while the projected Gini coefficient growth is at the higher end

of what has been seen historically, it is within the range possibility. An overview of the methodology used for producing the Gini estimations in this report was provided.

## Supporting Data & Literature

The World Income Inequality Database (WIID)<sup>129</sup> is a widely recognized source of statistics on income inequality.<sup>130</sup> How the projected increase in Gini data used in this analysis compared with historical examples of changing Gini values was also explored. The WIID data was assessed to see if the following could be found:

- a) Year-on-year change that exceeded the average level of year-on-year change in Gini coefficient estimated for Yemen in this report (4.6 points),
- b) Year-on-year change in the Gini coefficient for country-years also experiencing historical conflict that exceeds the year-on-year change in Gini coefficient estimated for Yemen in this report.

The report finds 494 instances of year-on-year change in Gini that equal or exceed the 4.6 average change reported for Yemen between 2014–2019. Additionally, there are also a total of 12 instances of year-on-year change in Gini that exceed the *total* change in Gini reported here (23 points).

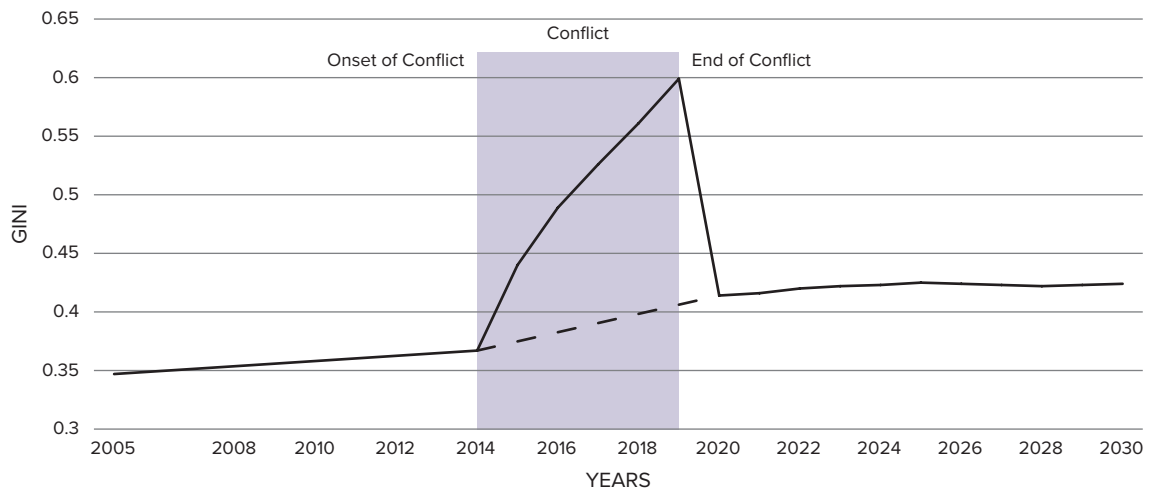
When the WIID data is restricted to countries in conflict, 32 instances where year-on-year change (positive or

negative) in Gini equals or exceeds 4.6 points can be observed. This assessment of these data provide some support that our estimated Gini for the years 2014–2019 in Yemen in the *Conflict 2030* scenario is possible.

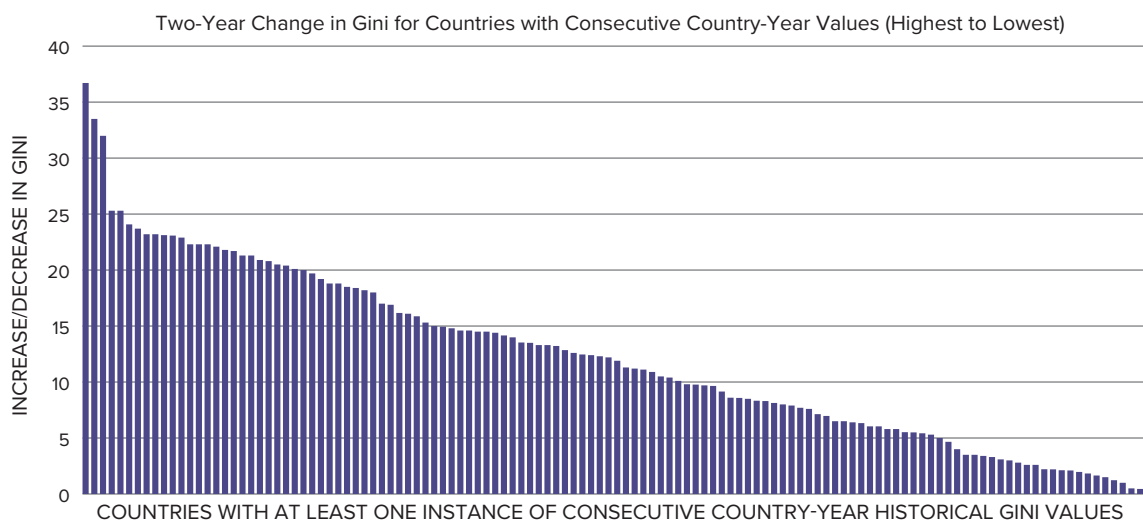
The academic literature provides some insights onto the relationship between conflict driving income (vertical) inequality. Bircan et al. (2017)<sup>131</sup> report that, on average, civil wars tend to “increase inequality by 1.6–1.9 points as measured by the Gini coefficient during war, and they increase inequality further by 1.5–2.1 points in the 10 years following the end of war” (p. 131–132). Additionally, they report that “civil wars fought over the control of government are estimated to lead to a 2.5 point increase in inequality during war, while they increase the level of post-conflict inequality by a further 2.4 points” (p. 136). These results are much lower than the 23-point increase identified in this report.

An additional piece of validation comes from a study by Tiwari (2017),<sup>132</sup> who uses a microsimulation approach to project the effects of conflict on poverty in Yemen using the 2014 Household Budgetary Survey data. The poverty projections produced from this study were used along with other published projections to inform a benchmarking exercise for the calibration of poverty variables in the IFs model.<sup>133</sup> Along with projections of poverty however, the piece from Tiwari overviews projected inequality statistics,

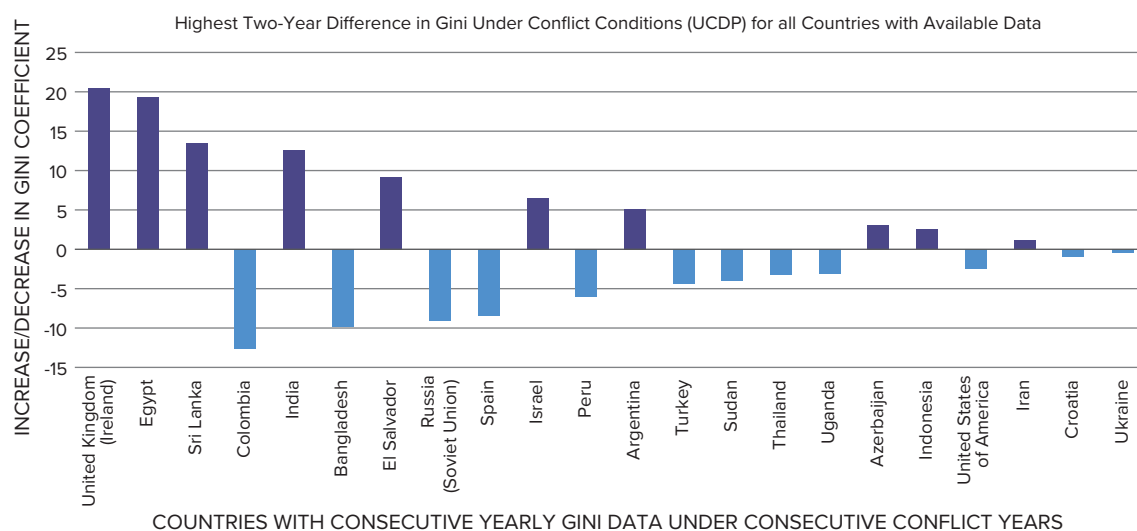
**FIGURE 11** | *Estimated increase in the Gini coefficient since conflict onset. Conflict period is shaded in purple. Future years depicted are from the Conflict 2019 scenario. Under this scenario, Gini is assumed to fall after conflict termination to around 4 points above the level of income inequality recorded in 2014.*



**FIGURE 12** | *Cross-country distribution of year-on-year change (positive or negative) in Gini coefficient found within the WIID 4.0. Countries are ordered left to right according to maximum value by country found in any two consecutive country-years.*



**FIGURE 13** | *Cross-country distribution of year-on-year change (positive or negative) in Gini coefficient found within the WIID 4.0. Observations are restricted to country-years which also appear in the UCDP/PRIO Armed Conflict Dataset version 19.1. Countries are ordered left to right according to maximum value by country found in any two consecutive country-years. Purple bars depict increases in Gini, while blue bars depict decreases.*



including Gini coefficient, for 2016. Here, the Gini index projections from 2016 from the Tiwari study match the Gini index projections from our study for 2016, at a value of 48.9. As no data from the Tiwari (2017) piece as *direct* inputs into the IFs system during model calibration was used, this provides support

both for the findings in Tiwari (2017), as well as additional validation of the methodological process used to estimate and project the Gini coefficient in this study, at the very least for the years 2014–2016. The technical estimation process is explained in further detail below.

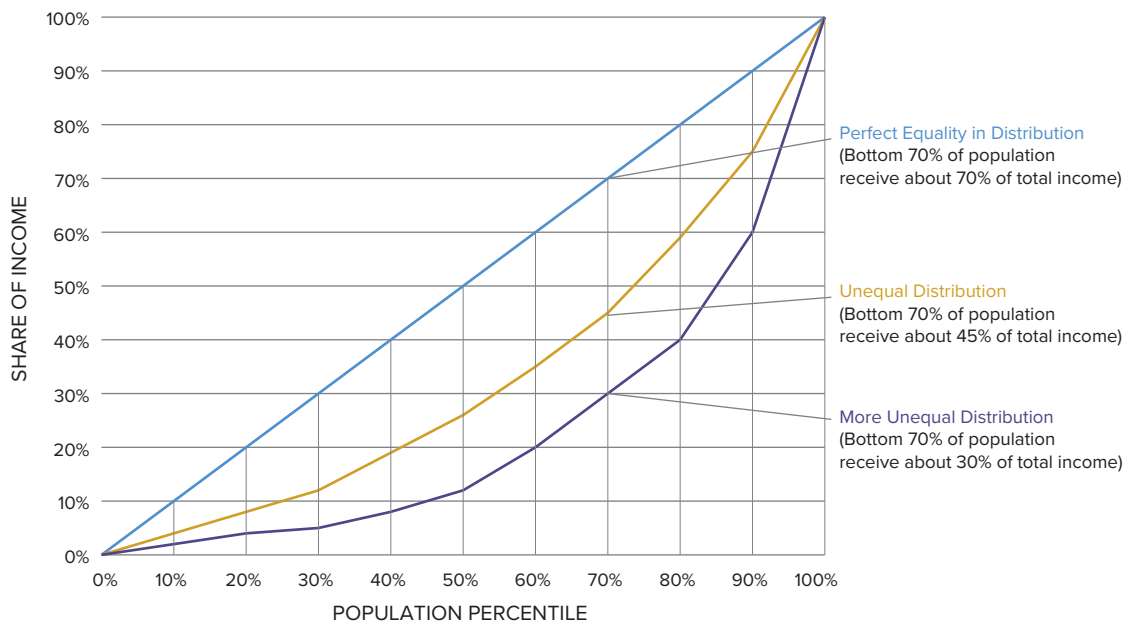
## Technical Estimation of Gini<sup>134</sup>

Due to the lack of directly relevant empirical studies since Bircan et al. (2017) and Tiwari (2017), and no available Gini data for Yemen since 2014, it was chosen in this report to estimate the Gini index mathematically. This approach draws on a commonly used method for estimating poverty and uses model-based poverty estimates (overviewed in Moyer et al., 2019, Annex 1),<sup>135</sup> mean consumption from IFs, and the assumption of a log-normal distribution of income as inputs. Acknowledging that the accuracy is dependent on the veracity of these input variables and the verisimilitude

of the log-normal assumption, this approach is viewed as an important step towards better understanding how inequality has and will evolve in Yemen.

The approach for estimating Gini here can be summarized basically as a reverse estimation given poverty and mean consumption (and following the assumption of a lognormal distribution of income). The use of distributions in forecasting begins with the distinction between a detailed distribution and the simpler parametric representation of such a distribution. By far the most widely used method for detailing distributions of income, wealth, or other quantities is the Lorenz curve (Figure 14), which can represent any survey data on income or consumption for a society with essentially complete accuracy.

**FIGURE 14** | *Illustration of stylized Lorenz Curves. The cumulative share of any variable such as consumption, wealth, income, etc., can be represented on the Y axis, while the cumulative share of the population in quintiles, deciles, etc. can be represented on the X axis. Here is an example which plots cumulative income share (Y) against population deciles (X).*



Although it would be possible to simply project forward the quintile or decile shares of a Lorenz curve to specify future income distributions, doing so has significant methodological shortcomings, including largely freezing the form of those distributions (which are typically dynamic over time), and not directly facilitating the computation of key poverty indexes such as the headcount of those with less than USD 1.90 per day.

IFs instead utilizes an analytics representation of the income distribution in the form of lognormal formulation, which allows responsiveness to both changing average income levels and changing income distributions (represented by the Gini coefficient). The use of a

lognormal representation of income is both substantiated largely by historical analysis of actual national income distribution,<sup>136</sup> as well as widely used in the economics literature.<sup>137</sup>

A lognormal distribution that fully represents the distribution of income in a society can be specified with only two parameters: average income and the standard deviation of it. Very usefully for the purposes of modeling future trends, the Gini coefficient can be used in lieu of the standard deviation. The Lorenz curve and standard poverty measures, including the size and earnings of various segments (such as quintiles or deciles) are then easily computable from the lognormal equation with the two aforementioned parameters.<sup>138</sup>

For the purposes of calibrating the model to the various scenarios of conflict in Yemen, this formulation also allows us to estimate Gini given empirical and model-based values of average consumption and the level of poverty. The graph below approximates the income distribution in Yemen in the year 2014. It is described by the probability density function of a log-normal distribution, and can be written as

$$f_x(x) = \frac{1}{x\sigma_x\sqrt{2\pi}} e^{-\frac{[\ln(x)-\mu_x]^2}{\sigma_x^2}}$$

where  $f_x(x)$  is the share of the population that can be founding living on  $x$  dollars per day and  $\mu_x$  and  $\sigma_x$  are the mean and standard deviation.

Aitchison and Brown<sup>139</sup> and Chotikapanich et al.<sup>140</sup> show that the Gini index ( $G$ ) can be expressed as

$$G = 2\Phi\left(\frac{\sigma_x}{\sqrt{2}}\right) - 1$$

where  $\phi$  is the standard normal distribution, and which can be used to evaluate  $\sigma_x$

$$\sigma_x = \sqrt{2}\Phi^{-1}\left(\frac{G + 1}{2}\right)$$

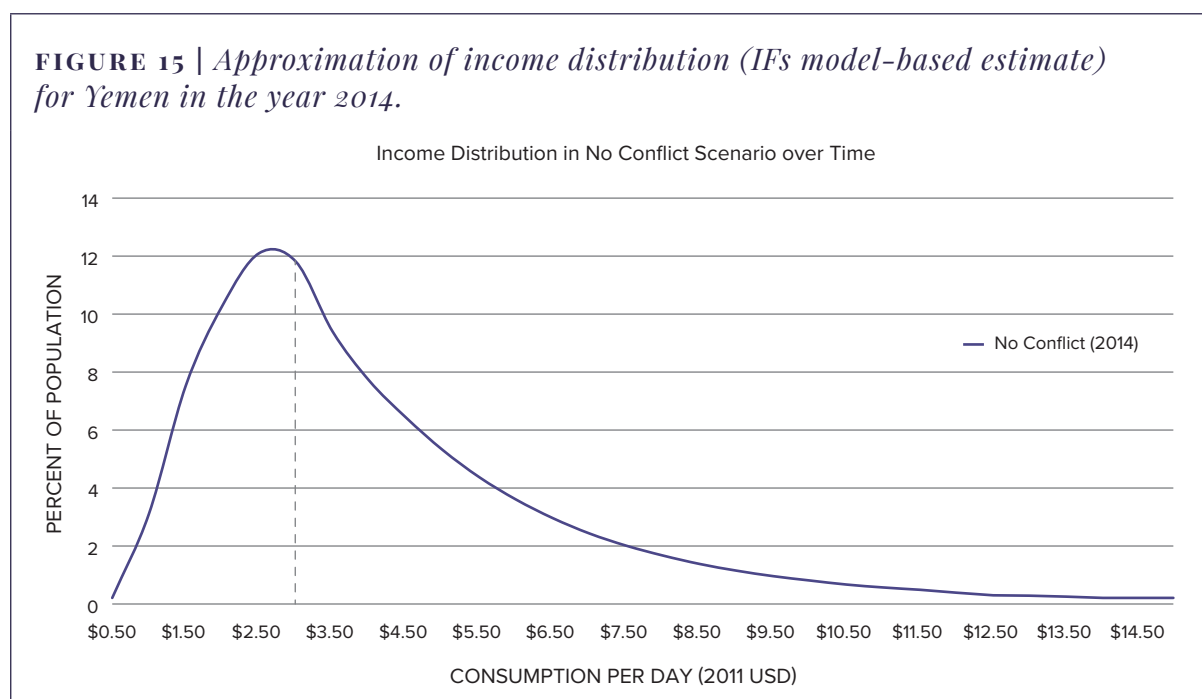
Finally, given mean household consumption,  $\mu$ , one can estimate as  $\mu_x$

$$\mu_x = \ln(\mu) - \frac{1}{2}\sigma_x^2$$

Having now the distribution of consumption,  $f_x(x)$ , expressed as a function of mean consumption and Gini, the portion of the population living below a given threshold,  $p$ , can be evaluated simply as the integral

$$p = \int_0^x f(x)dx$$

Given this framework for estimating poverty and extant estimates of poverty rates in Yemen found in simulation studies by Arezki et al.<sup>141</sup> and Tiwari,<sup>142</sup> as well as estimations of mean household consumption from the IFs system, IFs allows for the estimation of Gini from reverse calculation from the framework above.



# ENDNOTES

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- 2 The indicators are drawn from variables related to SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), SDG 6 (Clean Water and Sanitation) and SDG 7 (Affordable and Clean Energy). Variables measuring similar indicators are averaged before distance is calculated.
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- 5 Moyer et al.
- 6 IFs is a free and open-source quantitative tool for understanding long-term futures and includes the following interconnected sub-modules: agriculture, demographics, economics, education, energy, environment, gender, governance, health, infrastructure, international relations and technology. The IFs tool projects development patterns for hundreds of variables across these issue areas for 186 countries.
- 7 It has been under development for four decades and used widely for policy and academic publication. For instance, see: Drew Bowlsby et al., "The Future Is a Moving Target: Predicting Political Instability," *British Journal of Political Science*, undefined/ed, 1–13, <https://doi.org/10.1017/S0007123418000443>; Barry B. Hughes, "International Futures (IFs) and Integrated, Long-Term Forecasting of Global Transformations," *Futures, Modelling and Simulation in Futures Studies*, 81 (August 1, 2016): 98–118, <https://doi.org/10.1016/j.futures.2015.07.007>; Jonathan D. Moyer and David K. Bohl, "Alternative Pathways to Human Development: Assessing Trade-Offs and Synergies in Achieving the Sustainable Development Goals," *Futures*, November 2018, <https://doi.org/10.1016/j.futures.2018.10.007>; Jonathan D. Moyer et al., "Africa's Path to 2063: Choice in the Face of Great Transformation" (Denver, CO and Midrand, Johannesburg: Frederick S. Pardee Center for International Futures and NEPAD Planning and Coordinating Agency, 2018); Xuantong Wang et al., "Estimation and Mapping of Sub-National GDP in Uganda Using NPP-VIIRS Imagery," *Remote Sensing* 11, no. 2 (January 2019): 163, <https://doi.org/10.3390/rs11020163>.
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- 11 Rabah Arezki et al., "A New Economy in Middle East and North Africa," Middle East and North Africa Economic Monitor, October (Washington, DC: World Bank, October 2018), <https://doi.org/10.1596/978-1-4648-1367-2>; Rabah Arezki et al., "Economic Transformation," Middle East and North Africa Economic Monitor, April (Washington, DC: The World Bank, 2018).
- 12 IFs produces estimates of a user-specific poverty line following a common approach utilizing lognormal density estimation informed by income distribution measures and population. To see a description of how this is calculated, visit: IFs in Barry B. Hughes et al., *Reducing Global Poverty*, vol. 1, Patterns of Potential Human Progress (Denver: Boulder: New Delhi: Pardee Center for International Futures, University of Denver; Paradigm Publishers; Oxford University Press India, 2009), [https://pardee.du.edu/sites/default/files/PPHP1\\_Full\\_Volume.pdf](https://pardee.du.edu/sites/default/files/PPHP1_Full_Volume.pdf). See overviews of this methodology in François Bourguignon, "The Poverty-Growth-Inequality Triangle," Working Paper (New Delhi: Indian Council for Research on International Economic Relations (ICRIER), 2004).
- 13 Depth of poverty is measured by the poverty gap index, a measure that sums up the distance between actual incomes and the poverty line. A large poverty gap and a large number of people in extreme poverty capture both the breadth and depth of poverty. An alternative measure, the squared poverty gap, is also useful for assessing the depth of poverty and provides an increased weight to populations living further below the poverty threshold. This indicator cannot be assessed for Yemen due to insufficient household survey data. However, the two measures are highly coordinated and nearly identical in their distribution, with a coefficient of determination ( $R^2$ ) of 0.98.
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- 18 Devarajan and Mottaghi, "Growth Slowdown Heightens Need for Reforms."
- 19 The International Futures (IFs) model and database is the most frequently used source of data and forecasts in this report. If no external attribution is provided for an in-text statistical reference, the source is *International Futures (IFs) modeling system, Version 7.40 IP1*. Frederick S. Pardee Center for International Futures, Josef Korbel School of International Studies, University of Denver, Denver, CO. The IFs historical database houses over 4,500 data series and primary sources and metadata can be found by accessing the database.
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