Foresight Project on
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A Foresight Study of Scenarios,
Challenges and Policy Opportunities

Working paper: WP1

Projections of food consumption and the health impacts associated with changes in dietary and weight-related risk factors

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Abstract:

Dietary and weight-related risk factors currently account for a greater burden of disease than any other group of risk factors. Here we estimate the changes in the health burden that is due to changes in selected dietary and weight-related risk factors for the year 2035 for 155 world regions. For our analysis, we linked the IMPACT agriculture-economic model, which we used to project future food consumption, to a comparative risk assessment of changes in fruit and vegetable consumption, red meat consumption, bodyweight among adults, and moderate and severe stunting among children. We find that changes in dietary and weight-related risk factors between 2015 and 2035 could lead to 76 million DALYs saved, corresponding to 1.7 million avoided deaths globally. About half of the DALYs are projected to be saved in South East Asia, 25% in the Western Pacific, 20% in Africa, and 2% in high-income countries, among others. Most DALYs were saved due to increased fruit and vegetable consumption (67 million), followed by reductions in underweight (31 million) and stunting (19 million), but they were partly offset by additional DALYs due to increased prevalence of obesity (27 million) and overweight (3 million), and increased red meat consumption (12 million).

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1 Introduction

The global burden of disease and its risk factors are shifting from communicable diseases associated with undernutrition and poor sanitation to non-communicable diseases associated with high body weight and unbalanced diets. It was estimated that in 2010, coronary heart disease, stroke, cancer, and other non-communicable causes were responsible for two out of three deaths worldwide,[1] and that dietary and weight-related risk factors, constituted two of the most important risk factors in aggregate and in most regions.[2] Together, they accounted for half of all attributable deaths in 2013 and for more than a third of attributable disability-adjusted life years.[3] In comparison, the most important risk factor of 1990, child and maternal malnutrition, accounted for 5% of attributable deaths and 18% of attributable DALYs in 2013.[3]

Going forward, risk factors associated with unbalanced diets and high body weight are projected to increase in importance. Diets, in particular in industrializing and developing countries, are shifting towards Western dietary patterns high in meat and processed foods.[4,5] Globalization and urbanisation, which lead to greater availability of energy-dense foods and more sedentary lifestyles, contribute to rising obesity levels worldwide.[6,7] Thus, changes in the future burden of disease will critically depend on changes in dietary factors and weight status.

Here we estimate the region-specific changes in food consumption and the health burden associated with changes in selected dietary and weight-related risk factors for the year 2035 for 155 world regions. Besides the common dietary and weight-related risk factors that are associated with non-communicable diseases among adults, such as low fruit and vegetable consumption, high red meat consumption, and high body weight, we also included in our analysis those risk factors with relevance to child and maternal malnutrition that are commonly used as indicators of food security, such as child undernourishment, and moderate and severe stunting.

2 Methods

We used a coupled agriculture-health modelling framework, depicted in Figure 1, to generate dietary and health projections to 2035 for 155 countries. The framework includes a detailed agricultural model to produce future trends in production and consumption under different socio-economic development pathways, and a global comparative risk assessment model to estimate changes in disease mortality associated with changes in dietary and weight-related risk factors. The results show the difference in global food production between 2015 and 2035, and the consequent impact on health outcomes. For health outcomes, the results should be interpreted as the marginal change that is due solely to differences in diet between 2015 and 2035 (i.e. the results do not predict health outcomes in 2035, which will be further influenced by many non-dietary factors that are not included in the modelling framework).

2.1 *Agricultural modelling framework*

The agricultural modelling framework relied on the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) which uses economic, water, and crop models to simulate global food production, consumption, and trade of 62 agricultural commodities for 159 world regions (155 of which could be used in the health analysis, see Appendix A1).[8,9] Within each region, supply and demand for agricultural commodities are determined, and each region is linked through trade with world commodity prices that clear international markets. Food production is modelled as a function of commodity and input prices, resource constraints of land, water and climatic conditions, and exogenous trends, e.g. of harvested area and yields; and food demand is modelled as a function of commodity prices, per-capita income, and total population (the latter two of which are subject to scenario assumptions).

We used the IMPACT model to produce global food scenarios for the years 2015 and 2035. We based our future food scenarios on different visions of the future that were developed by the international research community (see Appendix A2 for a detailed overview).[10] For our main scenario, we adopted a "middle-of-the-road" socioeconomic trajectory (SSP2) which follows historical trends in GDP and population growth and is based on GDP projections developed by the Organization for Economic Co-operation and Development (OECD) and population projections developed by the International Institute for Applied Systems Analysis (IIASA).[11,12] For analysing the sensitivity to different socio-economic developments, we adopted two alternative socio-economic pathways in the sensitivity analysis: a "Sustainability"-termed socio-economic pathway (SSP1) which is characterized by medium to high economic growth and low population growth, and a "Fragmentation"-termed socio-economic pathway (SSP3) which is characterized by slow economic growth and high population growth.[13]

2.2 *Model coupling*

We used three different outputs from the IMPACT model in our health assessment of dietary and weight-related risk factors. Changes in the availability of specific food groups were used in a dietary risk assessment for adults (aged 20 and older), changes in total calorie availability were used in a weight-related risk assessment for adults, and changes in the prevalence of undernourished children (estimated in IMPACT's food security module) were used to in a risk assessment focussed specifically on children (aged five and younger).

For the dietary risk assessment, we converted the food availability estimates produced by IMPACT into food consumption estimates by using regional data on food wastage at the consumption/household level, combined with conversion factors that subtract non-edible parts of foods.[14]

For the weight-related risk assessment, we estimated changes in weight as shifts in the baseline weight distribution by using the historical relationship between national food availability and mean body mass index (BMI). We estimated the baseline distribution by fitting a log-normal distribution to estimates from the World Health Organization (WHO) of mean BMI and the prevalence of overweight and obesity using a cross-entropy method,[15] which jointly minimizes the deviation of the prevalence of overweight and obesity for each mean BMI estimate. We derived the shifts in the weight distribution related to changes in food availability by pairing food availability data from the Food and Agricultural Organization of the United Nations (FAO) for the years 1980-2009 with WHO data on mean BMI for the same period, using a polynomial trend to describe their relationship ($R^2 = 0.50$, $p<0.001$).

For analysing the weight-related health burden for children, we included two separate risk factors, moderate and severe stunting. Children are considered moderately stunted if they are more than two standard deviations below the expected mean ratio of height-for-age, and severely stunted if they are three standard deviations below that ratio. We estimated the future prevalence of moderate and severe stunting using a model that resolves the food and non-food (socio-economic) causes of stunting.[16] As proxy for food-related causes, we used IMPACT-based estimates of the percentage of undernourished children which are based on a relationship of per capita calorie consumption, female access to secondary education, the quality of maternal and child care, and health and sanitation;[17] and as proxy for non-food causes of stunting, we followed Lloyd and colleagues in constructing a development score based on future projections of GDP per capita and current Gini coefficient.[16]

2.3 Health modelling framework

We analysed the health impacts associated with changes in food consumption by using a comparative risk assessment framework with five disease states and eight diet and weight-related risk factors. The disease states included coronary heart disease (CHD), stroke, type 2 diabetes (T2DM), cancer (which is an aggregate of site-specific cancers), and an aggregate for all other causes. The four specific disease states accounted for more than 60% of deaths from non-communicable diseases and for more than 40% of deaths globally in 2013.[3] The weight-related risk factors corresponded to the four weight classes of underweight (BMI<18·5), normal weight (18·5<BMI<25), overweight (25<BMI<30), and obesity (BMI>30), as well as the prevalence of moderate and severe stunting among children. The diet-related risk factors included fruit and vegetable consumption and red meat consumption which, together, accounted for about half of all deaths that were attributable to diet-related risks in 2013.[3]

We estimated the mortality and disease burden attributable to dietary and weight-related risk factors by calculating population attributable fractions (PAFs). PAFs represent the proportions of disease cases that would be avoided when the risk exposure was changed from a baseline situation (the diet and weight-related risk levels of 2015) to a counterfactual situation (the diet and weight-related risk levels of 2035). For calculating PAFs, we used the general formula:[2,18]

$$PAF = \frac{\int RR(x)P(x)dx - \int RR(x)P'(x)dx}{\int RR(x)P(x)dx} \quad (1)$$

where $RR(x)$ is the relative risk of disease for risk factor level x, $P(x)$ is the number of people in the population with risk factor level x in the baseline scenario, and $P'(x)$ is the number of people in the population with risk factor level x in the counterfactual scenario. We assumed that changes in relative risks follow a dose-response relationship,[2,19] and that PAFs combine multiplicatively,[2,20] i.e. $PAF_{TOT} = 1 - \prod_i (1 - PAF_i)$ where the i's denote independent risk factors.

We used publically available data sources to parameterize the comparative risk analysis. Population and mortality data by region and 5-year age group for the years up to 2035 were adopted from IIASA in line with the socio-economic development pathways used. We decomposed all-cause mortality rates into cause-specific ones for CHD, stroke, T2DM, an aggregate of cancers, and an aggregate of all other causes by using burden of disease estimates for WHO member states in 2012. In addition to changes in mortality, we calculated the proportion of disability-adjusted life years (DALYs) associated with such changes by using region and age-specific mortality-DALY ratios calculated from WHO estimates for the year 2012. This method of extending the analysis to incorporate the burden of disease associated with morbidity follows the assumption that differences in mortality predicted by the model are entirely mediated by changes in incidence of disease, and not by changes in case fatality.

We restricted the selection of relative risk parameters to meta-analyses and pooled prospective cohort studies. Table 1 provides an overview of the relative risk parameters used. The diet and weight-related relative risk parameters were adopted from pooled analyses of prospective cohort studies,[21,22] and from meta-analysis of prospective cohort and case-control studies.[23–28] The cancer associations have been judged as probable or convincing by the World Cancer Research Fund, and in each case a dose-response relationship was apparent and consistent evidence suggests plausible mechanisms.[27]

3 Results

3.1 Food availability and consumption

An important determinant for energy intake and weight-related risk factors, such as underweight, overweight, obesity, is calorie availability. According to our analysis (Table 2), global calorie availability in a "middle of the road" development pathway is projected to increase by 8% (232 kcal/cap/day), from 2,860 kcal per capita per day (kcal/cap/day) in 2015 to 3,090 in 2035. Low and middle-income countries exhibit stronger growth than high-income countries, albeit from a lower baseline. Calorie availability in low and middle-income countries is projected to grow by 12-13% (310-390 kcal/cap/day) in the Western Pacific, South-East Asia, and Africa; and 5-7% (160-200 kcal/cap/day) in the Americas, Europe, and the Eastern Mediterranean. In comparison, calorie availability in high-income countries is projected to grow by 2% (70 kcal/cap/day).

Figure 2 decomposes the changes in total calorie availability into different food groups. Globally, changes in the fruits and vegetables consumption contribute 21% to the total changes in calorie availability, sugars 18%, oils 16%, cereals 14%, dairy 8%, poultry 6%, pulses 6%, roots and tubers 5%, other crops 4%, red meat 3%, and eggs 1%. The composition varies by regions. The relative contributions from oils and red meat are higher in low and middle income countries, whereas those from poultry are higher in high-income countries.

The dietary risk factors considered in our health assessment are changes in fruits and vegetable consumption and changes in red meat consumption. According to our projections (Table 2), global fruits and vegetable consumption (net of waste) is projected to increase by 21% or 77 grams per capita per day (g/cap/day) and global red meat consumption to increase by 6% or 4 g/cap/d between 2015 and 2035. Lower than average increases in fruit and vegetable consumption are projected for high-income countries (29 g/cap/day; 8%), and for the low and middle income countries of the Eastern Mediterranean (39 g/cap/d; 12%), the Americas (43 g/cap/d; 14%), and Europe (62 g/cap/d; 18%); and higher than average increases are projected for the low and middle income countries of South East Asia (171 g/cap/d; 69%), the Western Pacific (94 g/cap/d; 14%), and Africa (81 g/cap/d; 38%). Lower than average increases in red meat consumption are projected for high-income countries (1 g/cap/d; 1%) and the low and middle income countries of South East Asia (3 g/cap/d; 34%), and higher than average increases are projected for all other low and middle income countries (Western Pacific: 19 g/cap/d or 17%, the Eastern Mediterranean: 9 g/cap/d or 46%, Africa: 8 g/cap/d or 43%, the Americas: 7 g/cap/d or 8%, and Europe: 6 g/cap/d or 9%).

3.2 Weight-related risk factors

Related to the changes in calorie availability are changes in weight-related risk factors. Those include changes in weight status among adults and the prevalence of undernourishment and stunting among children. Table 3 provides an overview of the changes in those risk factors.

Among adults, we project the global prevalence of underweight to decrease by 19% (2.3 percentage points) between 2015 and 2035, and the prevalence of overweight and obesity to increase by 9% (2.4 percentage points) and 16% (1.9 percentage points), respectively. Greater changes in either direction are projected for the low and middle income countries of South East Asia (with changes in the prevalence of underweight, overweight, and obesity by -24%, +24%, and +51%, respectively), Africa (-26%, +20%, +33%), and in parts for the Western Pacific (-17%, +9%, +24%). In high-income countries, the prevalence of underweight, overweight, and obesity is projected to change by -7%, +1%, and +5%, respectively.

Among children, we project global reductions in the prevalence of undernourishment of 14% (2.6 percentage points), and associated with that, reductions in the prevalence of moderate and severe stunting of 19% (2.2 percentage points) and 40% (2.5 percentage points), respectively. In line with changes in underweight, the decrease in the prevalence of undernourished and stunted children is greater than the global average in the low and middle income countries of the Western Pacific (with percentage point reductions in undernourishment, and moderate and severe stunting of 4.7, 3.6, and 0, respectively), South East Asia (4.6, 4.3, 8.7), and Africa (5.5, 1.4, 1.5).

In the low and middle income countries of Europe, our analysis projects the prevalence of undernourished children to increase by 20%, in particular in Russia (75%) and Ukraine (68%). However, the prevalence of stunting in that region is still projected to decrease in aggregate in that region, because the increases in stunting in both Russia (+28%) and Ukraine (+19%) are small in absolute terms, and compensated in aggregate by reductions in stunting in other countries of that region.

3.3 Health impacts

We quantified the health impacts associated with the changes in dietary and weight-related risk factors in terms of changes in the number of deaths, premature deaths defined as deaths occurring before the age of 70, and disability-adjusted life years (DALYs). Figure 3 shows the results of our health assessment by region and risk factor (results for individual countries are listed in Appendix A3).

We estimate that the changes in dietary and weight-related risk factors from 2015 to 2035 could lead to 76 million DALYs saved or to 1.7 million avoided deaths globally, 1 million of which are premature deaths. Those impacts amount to 2% of all projected deaths in 2035 and to 2.8% of projected DALYs. About half of the DALYs saved due to changes in dietary and weight-related risk factors are projected to be saved in South East Asia (48% of avoided deaths), 25% in the Western Pacific (34% of avoided deaths), 20% in Africa (12% of avoided deaths), and the remainder in other regions, including 2% in high-income countries (3% of avoided deaths).

Decomposing the health impacts by risk factor shows opposing impacts. Changes in dietary risk factors led to 55 million DALYs saved (1.6 million deaths avoided), which were composed of 67 million DALYs saved (2 million deaths avoided) due to increased fruits and vegetable consumption, and 12 million additional DALYs (430,000 additional deaths) due to increased red meat consumption. Changes in weight-related risk factors among adults led to 1 million DALYs saved (140,000 deaths avoided), which were composed of 31 million DALYs saved (700,000 deaths avoided) due to a lower proportion of people who are underweight, 3 million additional DALYs (100,000 additional deaths) due to a greater proportion of people who are overweight, and 27 million additional DALYs (740,000 additional deaths) due to a greater proportion of people who are obese. Changes in stunting among children led to 19 million DALYs saved (200,000 deaths avoided).

Figure 4 illustrates the relative importance of each risk factor by region in terms of per-capita health impacts. Changes in fruit and vegetable consumption accounted for the greatest portion of all additional or saved DALYs in high-income countries (39% of all additional or saved DALYs across risk factors), and in the low and middle-income countries of Europe (34%), South East Asia (29%), and the Western Pacific (41%). Changes in obesity was the most important risk factor in the Americas (23%) and the Eastern Mediterranean (24%); and changes in underweight was the most important risk factor in Africa (32%). We also found significant contributions of changes in red meat consumption in the Western Pacific (10%), and of changes in stunting in Africa (19%) and South East Asia (11%).

3.4 Sensitivity analysis

In the sensitivity analysis, we analysed the health impacts of changes in dietary and weight-related risk factors for two different socio-economic development pathways. The first one (SSP1) is characterized by greater economic growth (GDP per capita is 18% higher) and less rapid population growth (4% less) compared to the main scenario in aggregate. As a result, the all-cause mortality rate is 14% lower in aggregate, total calorie availability per capita is 4% higher, and fruit and vegetable consumption and red meat consumption are 7% and 6% higher, respectively. The prevalence of underweight among adults and undernourishment among children is 9% and 6% lower, respectively, but the prevalence of overweight and obesity is 3% and 6% higher, respectively. The second development pathway (SSP3) is characterized by lower economic growth (GDP per capita is 14% less) and more rapid population growth (4% more) compared to the main scenario in aggregate. As a result, the all-cause mortality rate is 14% higher in aggregate, total calorie availability per capita is 3% lower, and fruit and vegetable consumption and red meat consumption are 6% lower each. The prevalence of underweight among adults and undernourishment among children is 10% and 8% higher, respectively, but the prevalence of overweight and obesity is 3% and 6% lower, respectively.

To compare those different development pathways in a structured way, we varied the dietary and weight-related risk factors and the underlying socio-economic parameters step by step. In a first comparison, we varied all dietary and weight-related risk factors, but left population and mortality rates constant at the main scenario’s levels. In a second comparison, we also varied the population projections, and in a third one, we allowed both the population projections and the morality rates to vary with the socio-economic pathway. Figure 5 details the global health impacts by risk factor for each sensitivity run.

In the first sensitivity run, results were as expected: higher food availability and consumption in SSP1 lead to a greater number of diet and weight-related DALYs saved, with positive impacts associated with increased fruit and vegetable consumption, and lower prevalence of underweight and child undernourishment exceeding the negative ones associated with increased red meat consumption and greater prevalence of overweight and obesity. Letting population projections vary with the different socio-economic scenarios in the second sensitivity run resulted in similar trends, because the consumption and weight changes were used in per-capita terms in each scenario and therefore already normalized by population.

The third sensitivity run which allowed all parameters and trends to vary with the socio-economic scenarios showed opposite results compared to the first two runs. The number of diet and weight-related DALYs saved were 20% higher in the SSP3 scenario, and 13% lower in the SSP1 scenario in aggregate. This suggests that the impacts of changes in mortality rates in the different socio-economic scenarios outweigh the differences in the changes in dietary and weight-related risk factors across the scenarios. For example, greater mortality rates in the SSP3 scenario and lower reductions in stunting compared to the main scenario resulted in a greater number of DALYs saved due to reductions in child stunting compared to combining lower mortality rates but greater reductions in stunting in the SSP1 scenario.

4 Discussion

Our analysis projected global food consumption and the associated health impacts of selected dietary and weight-related risk factors for the next twenty years. Our agriculture analysis suggest that food consumption and the associated dietary and weight-related risk factors could change substantially, in particular in low and middle income countries. The general trend in those regions is “more of everything”, i.e. more calories due to greater intake of vegetable oils and sugars, but also more fruits, vegetables and red meat.

Our health analysis suggests that those future changes in food consumption could affect dietary and weight-related risk factors and the associated health impacts in opposing ways. We project the health benefits associated with increased fruit and vegetable consumption to outweigh the negative health impacts associated with increased red meat consumption, but also that the health benefits associated with lower proportions of people who are underweight are mitigated in most aggregate regions (except for the low and middle income countries of Africa and Southeast Asia) by the negative health impacts associated with higher proportions of people who are overweight or obese.

Thus, our analysis portrays a complex picture of future changes in food consumption. We project most regions to experience net health benefits, in particular due to changes in dietary risk factors, but changes in total calorie availability and the associated changes in weight-related risk factors are projected to become zero-sum changes from a health perspective. This suggests that in order to realize greater improvements in diet and weight-related health outcomes, particular attention should be paid to countering the growth in the prevalence of overweight and obesity, and to some extent red meat, whilst safeguarding the projected benefits from increasing fruit and vegetable consumption and reducing the prevalence of underweight.

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Tables and figures

(in order of reference)

Figure 1: Agriculture-health modelling framework. The IMPACT global agriculture-economic model was used to simulate future food scenarios. Three outputs of those scenarios were used in a global health model to estimate the future burden of dietary and weight-related diseases: (i) changes in food availability, in particular fruits and vegetables and red meat, were converted into changes in food consumption by accounting for household waste; (ii) changes in calorie availability were used to estimate changes in a region's weight distribution by using historical relationships between food availability and mean body mass index; and (iii) changes in the prevalence of undernourished children were used, together with indicators of economic development, to estimate changes in moderate and severe stunting among children. Changes in those dietary and weight-related risk factors were used in the global health model to estimate changes in mortality and disability-adjusted life years by region, age group, risk factor, and disease.

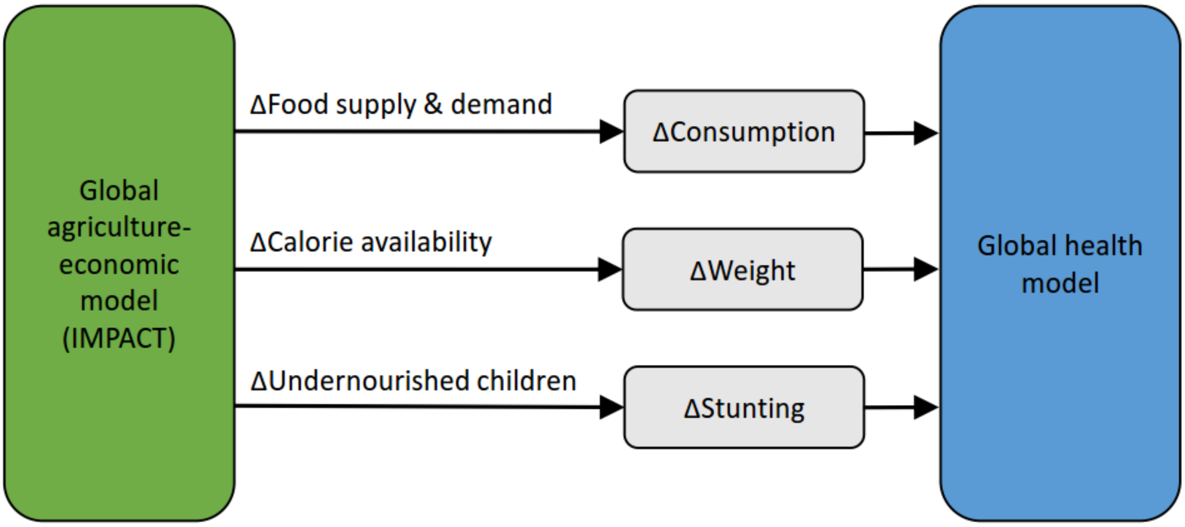


Table 1: Relative risk parameters (mean and 95% confidence intervals in parenthesis)

Risk factor	Relative risk per cause of death				
	CHD	Stroke	Cancer	T2DM	Other
Fruit and vegetable consumption	0.96 (0.93-0.99)	0.95 (0.92-0.97)	0.93 (0.84-0.99)*	0.96 (0.92-0.99)	1
Red meat consumption	1.25 (1.21-1.29)	1.10 (1.05-1.15)	1.01 (1.00-1.05)*	1.15 (1.07-1.24)	1
underweight	0.67 (0.65-0.70)	1.03 (0.71-1.47)	1.11 (0.94-1.32)	1	1.75 (1.50-2.05)
normal weight	1	1	1	1	1
overweight	1.31 (1.24-1.39)	1.07 (0.73-1.59)	1.10 (1.04-1.17)	1.54 (1.42-1.68)	0.96 (0.89-1.03)
obese	1.78 (1.64-1.92)	1.55 (1.14-2.11)	1.40 (1.30-1.50)	7.37 (5.16-10.47)	1.33 (1.22-1.46)
moderate stunting	1	1	1	1	1.6 (1.3-2.2)
severe stunting	1	1	1	1	4.1 (2.6-6.4)

* global average, actual relative risk is region-specific.

Sources: Dauchet et al (2005, 2006), Micha et al (2010), Chen et al (2013), WCRI/AIC (2007), Li et al (2014), Feskens et al (2013), Prospective Studies Collaboration (2009), Berrington de Gonzales et al (2010), Black et al (2008).

Table 2: Food consumption in 2015 and 2035 by food group and aggregate region. Aggregate regions include high-income countries (HIC), low and middle-income countries of Africa (AFR), America (AMR), the Eastern Mediterranean (EMR), Europe (EUR), South East Asia (SEA), the Western Pacific (WPR), and an aggregate of all regions (World). Absolute and percentage changes in food consumption are denoted by Δ and %, respectively.

Region	Year	Calorie availability (kcal/cap/d)	Food consumption (g/cap/d) by food group										
			Fruits & veg	Red meat	Poultry	Dairy	Eggs	Vegetable oils	Refined sugar	Cereals	Pulses	Roots & tubers	Other crops
World	2015	2542	377	64	33	230	24	20	60	301	17	138	33
	2035	2776	454	68	42	258	25	24	71	311	21	148	36
	Δ	232	77	4	9	28	1	4	12	10	4	10	3
	%	9%	21%	6%	27%	12%	5%	20%	19%	3%	21%	8%	10%
HIC	2015	2680	379	137	74	516	35	28	88	198	9	107	47
	2035	2753	408	139	84	523	34	28	92	202	10	105	48
	Δ	68	29	1	11	7	-1	0	4	3	1	-2	1
	%	3%	8%	1%	14%	1%	-2%	0%	5%	2%	8%	-2%	3%
AFR(LMIC)	2015	2323	211	20	11	77	5	21	32	291	29	341	25
	2035	2652	292	28	14	85	7	24	37	316	35	347	30
	Δ	334	81	8	4	9	1	4	5	26	6	7	5
	%	14%	38%	43%	35%	11%	24%	18%	17%	9%	19%	2%	21%
AMR(LMIC)	2015	2550	314	92	69	299	26	13	110	263	31	110	32
	2035	2694	357	99	83	325	27	15	119	265	35	106	33
	Δ	157	43	7	14	27	1	2	9	2	3	-4	0
	%	6%	14%	8%	21%	9%	6%	14%	8%	1%	10%	-3%	1%
EMR(LMIC)	2015	2419	324	20	19	291	9	20	71	316	18	51	17
	2035	2603	363	29	24	294	11	22	89	322	21	55	19
	Δ	192	39	9	5	4	1	3	18	6	3	4	2
	%	8%	12%	46%	27%	1%	14%	14%	25%	2%	15%	8%	11%
EUR(LMIC)	2015	2824	338	73	39	429	31	27	102	261	5	201	19
	2035	3022	401	80	50	426	32	29	117	275	5	193	23
	Δ	198	62	6	11	-3	1	2	15	13	0	-7	4
	%	7%	18%	9%	29%	-1%	3%	7%	14%	5%	6%	-4%	22%
SEA(LMIC)	2015	2256	246	10	10	163	9	18	54	371	25	74	28
	2035	2553	417	13	21	200	14	22	74	377	28	89	30
	Δ	307	171	3	11	37	5	5	19	7	4	15	3
	%	14%	69%	34%	111%	23%	56%	26%	36%	2%	14%	21%	10%
WPR(LMIC)	2015	2841	661	111	34	108	46	18	29	306	4	146	41
	2035	3214	755	130	51	204	51	27	41	311	5	148	51
	Δ	387	94	19	16	96	5	9	12	5	1	2	10
	%	14%	14%	17%	48%	89%	11%	50%	41%	2%	23%	1%	23%

Figure 2: Change in calorie availability (kcal/cap/d) by food group and region. Aggregate regions include high-income countries (HIC), low and middle-income countries of Africa (AFR), America (AMR), the Eastern Mediterranean (EMR), Europe (EUR), South East Asia (SEA), the Western Pacific (WPR), and an aggregate of all regions (World).

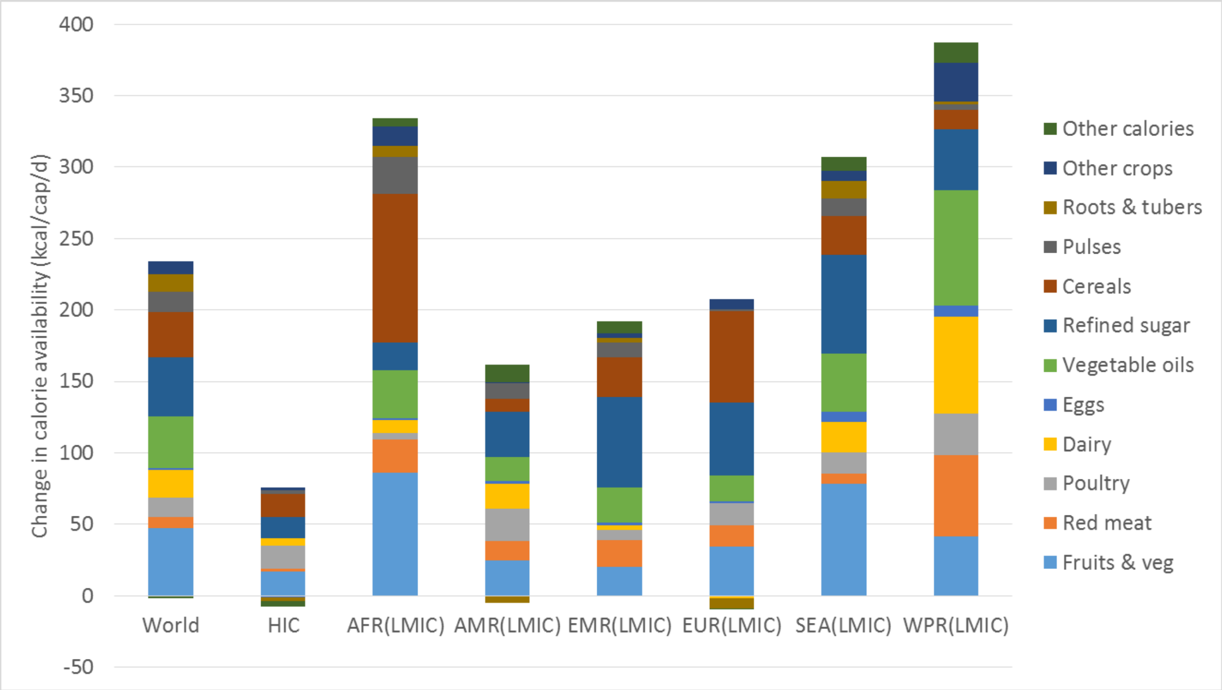


Table 3: Weight-related risk factors projected for 2015 and 2035. Aggregate regions include high-income countries (HIC), low and middle-income countries of Africa (AFR), America (AMR), the Eastern Mediterranean (EMR), Europe (EUR), South East Asia (SEA), the Western Pacific (WPR), and an aggregate of all regions (World). Absolute changes are denoted by Δ.

Region	Year	Prevalence of (%)						
		underweight	normal	overweight	obesity	child under-nourishment	moderate stunting	severe stunting
World	2015	11.9	50.2	25.9	12.0	18.8	11.4	6.3
	2035	9.6	48.2	28.3	13.9	16.2	9.2	3.8
	Δ	-2.3	-2.0	2.4	1.9	-2.6	-2.2	-2.5
HIC	2015	4.6	39.9	32.3	23.2	0.3	0.2	0.0
	2035	4.3	38.6	32.7	24.4	0.2	0.1	0.0
	Δ	-0.3	-1.3	0.4	1.2	-0.1	-0.1	0.0
AFR(LMIC)	2015	18.1	51.2	21.7	9.0	26.7	18.5	13.6
	2035	13.4	48.6	26.0	12.0	21.2	17.1	12.1
	Δ	-4.7	-2.6	4.3	3.0	-5.5	-1.4	-1.5
AMR(LMIC)	2015	4.2	38.3	34.5	23.0	7.1	9.6	4.3
	2035	3.5	36.0	35.2	25.3	5.0	4.8	0.8
	Δ	-0.7	-2.4	0.7	2.3	-2.1	-4.8	-3.4
EMR(LMIC)	2015	7.3	47.3	28.6	16.9	22.3	14.8	8.8
	2035	5.8	44.0	30.9	19.2	19.1	12.2	7.1
	Δ	-1.5	-3.2	2.4	2.4	-3.2	-2.6	-1.7
EUR(LMIC)	2015	4.5	40.0	34.5	21.0	6.1	5.6	1.2
	2035	3.9	38.0	35.2	22.9	7.4	5.0	0.2
	Δ	-0.6	-2.1	0.7	1.9	1.2	-0.6	-1.0
SEA(LMIC)	2015	21.4	56.2	18.0	4.4	39.4	19.5	11.5
	2035	16.3	54.9	22.3	6.6	34.8	15.1	2.8
	Δ	-5.2	-1.3	4.3	2.2	-4.6	-4.3	-8.7
WPR(LMIC)	2015	8.8	58.5	26.6	6.1	9.4	6.5	1.6
	2035	7.3	56.1	29.1	7.6	4.7	2.9	1.6
	Δ	-1.5	-2.4	2.5	1.5	-4.7	-3.6	-0.0

Figure 3: Disability-adjusted life years saved due to changes in dietary and weight-related risk factors between 2015 and 2035. Risk factors include changes in fruit and vegetable consumption (FVC), red meat consumption (MTC), the prevalence of underweight (UND), overweight (OVW), obesity (OBS), and stunting (STN). Aggregate regions include high-income countries (HIC), low and middle-income countries of Africa (AFR), America (AMR), the Eastern Mediterranean (EMR), Europe (EUR), South East Asia (SEA), the Western Pacific (WPR).

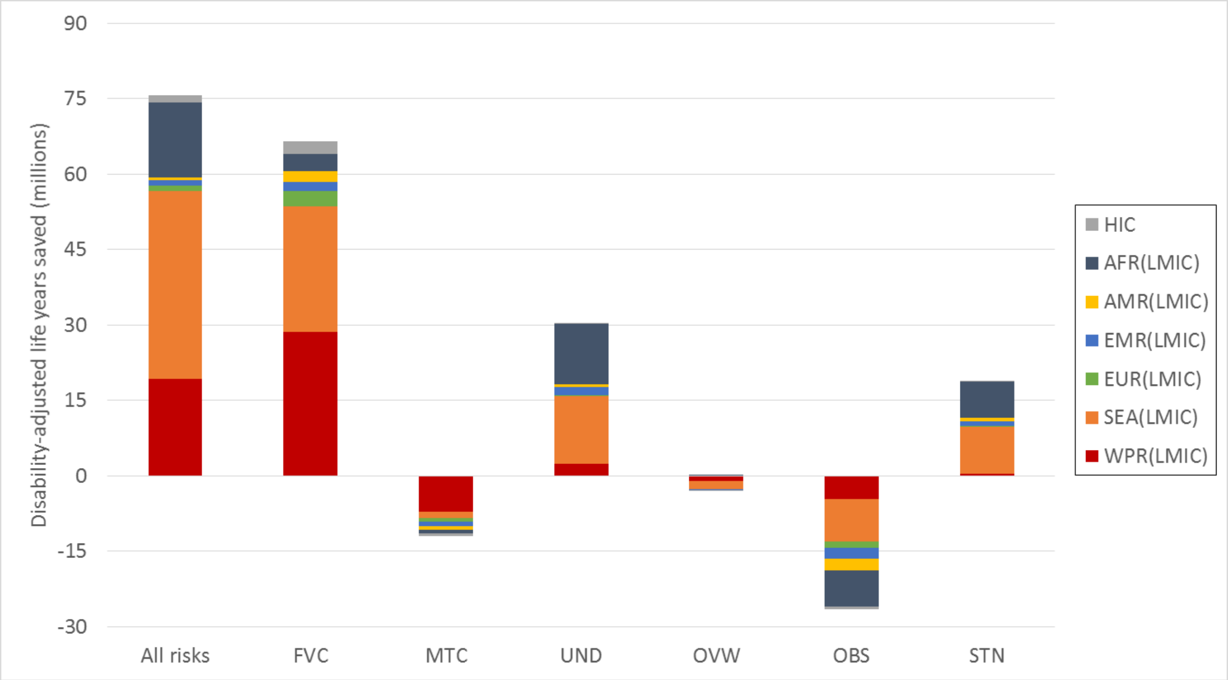


Figure 4: Disability-adjusted life years saved per thousand people by risk factor and region. Risk factors include changes in fruit and vegetable consumption (FVC), red meat consumption (MTC), the prevalence of underweight (UND), overweight (OVW), obesity (OBS), and stunting (STN). Aggregate regions include high-income countries (HIC), low and middle-income countries of Africa (AFR), America (AMR), the Eastern Mediterranean (EMR), Europe (EUR), South East Asia (SEA), the Western Pacific (WPR).

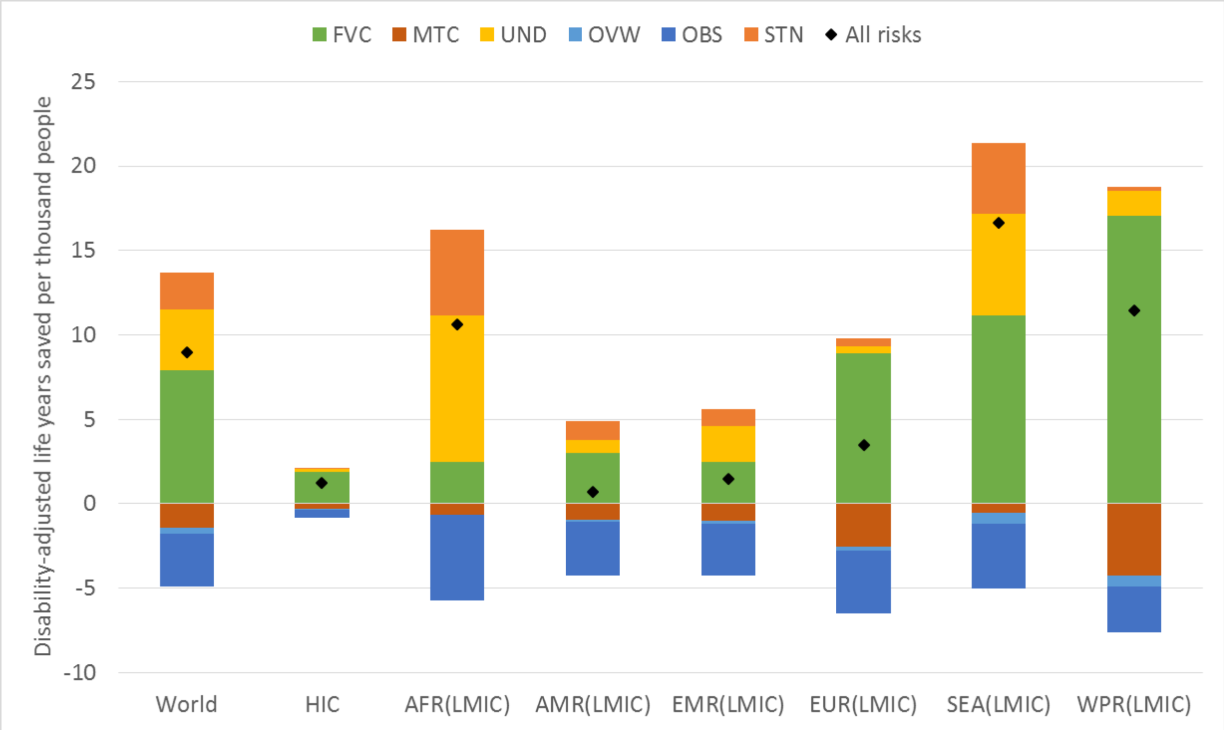
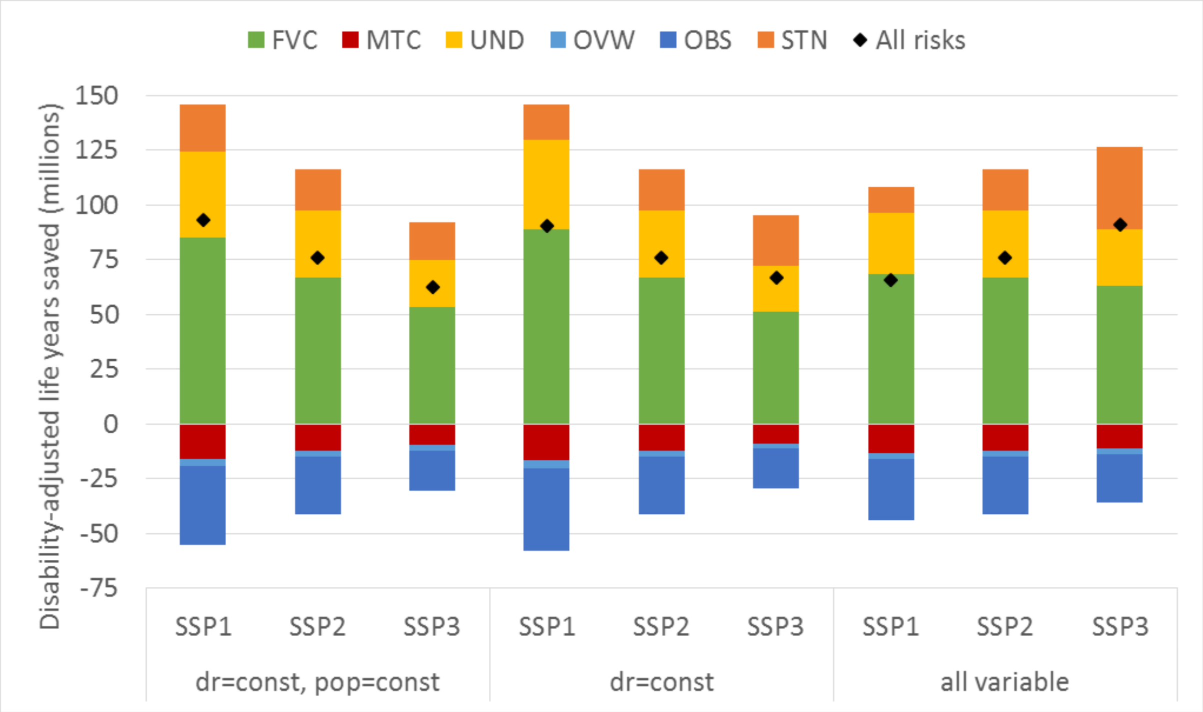


Figure 5: Sensitivity analysis with respect to different socio-economic pathways. SSP2 denotes a "middle of the road" development scenarios, SSP1 a "sustainability"-themed scenario with higher economic growth but lower population growth, and SSP3 a "fragmentation" scenario with lower economic growth but higher population growth. All socio-economic and consumption parameters vary in the third sensitivity run (all variable), mortality rates are held constant at SSP2-levels in the second sensitivity run (dr=const), and both mortality rates and population numbers are held constant at SSP2-levels in the first sensitivity run (dr=const, pop=const).



Appendix

A.1 Regional aggregation

Our analysis yielded results for 155 regions. We aggregated the results for individual countries into results for regional aggregates to provide an overview and ease the presentation of results. For that purpose, we used the WHO-World Bank classification. WHO Member States were classified according to the World Bank income category for the year 2011 (World Bank list of economies, July 2012) and WHO region:

HIC: high-income countries;
AFR_LMIC: low and middle-income countries of Africa;
AMR_LMIC: low and middle-income countries of America;
EMR_LMIC: low and middle-income countries of the Eastern Mediterranean;
EUR_LMIC: low and middle income countries of Europe;
SEA_LMIC: low and middle-income countries of South-East Asia;
WPR_LMIC: low and middle-income countries of the Western Pacific.

The assignment of countries to the regional aggregates is detailed below.

HIC High-income countries

* *AMR American Region:*

CAN Canada

CRB Other Caribbean

USA United States of America

* *EMR Eastern-Mediterranean Region:*

RAP Rest of Arab Peninsula

SAU Saudi Arabia

* *EUR European Region:*

AUT Austria

BLX Belgium and Luxembourg

CHP Switzerland

CYP Cyprus

CZE Czech Republic

DEU Germany

DNK Denmark

FNP Finland

FRP France

GRC Greece

HRV Croatia

HUN Hungary

IRL Ireland

ISL Iceland

ISR Israel

ITP Italy

NLD Netherlands

NOR Norway

POL Poland

PRT Portugal

SPP Spain

SVK Slovakia

SVN Slovenia

SWE Sweden

UKP United Kingdom

* *WPR Western Pacific Region:*

AUS Australia

JPN Japan

KOR Republic of Korea

NZL New Zealand

OSA Other Southeast Asia

(Note: GNQ, Equatorial Guinea, was re-classified as UMC in accordance with WHO mortality projections)

AFR_LMIC Low and middle-income Africa

BWA Botswana

DZA Algeria

GAB Gabon

GNQ Equatorial Guinea

NAM Namibia

ZAF South Africa

AGO Angola

CIV Côte d'Ivoire

CMR Cameroon

LSO Lesotho

NGA Nigeria

OAO Other Atlantic Ocean

OIO Other Indian Ocean

SWZ Swaziland

BDI Burundi

BEN Benin

BFA Burkina Faso

CAF Central African Republic

COD Democratic Republic of the Congo

COG Congo

ERI Eritrea

ETH Ethiopia

GHA Ghana

GIN Guinea

GMB Gambia

GNB Guinea-Bissau

KEN Kenya

LBR Liberia

MDG Madagascar

MLI Mali

MOZ Mozambique

MRT Mauritania

MWI Malawi

NER Niger

RWA Rwanda

SEN Senegal

SLE Sierra Leone

TCD Chad

TGO Togo

TZA United Republic of Tanzania

UGA Uganda

ZMB Zambia

ZWE Zimbabwe

AMR_LMIC Low and middle-income America

ARG Argentina

BRA Brazil

CHL Chile

COL Colombia

CRI Costa Rica

CUB Cuba

DOM Dominican Republic

JAM Jamaica

MEX Mexico

PAN Panama

PER	Peru
URY	Uruguay
VEN	Venezuela (Bolivarian Republic of)
BLZ	Belize
BOL	Bolivia (Plurinational State of)
ECU	Ecuador
GSA	Guyanas South America
GTM	Guatemala
HND	Honduras
NIC	Nicaragua
PRY	Paraguay
SLV	El Salvador
HTI	Haiti

EMR_LMIC Low and middle-income Eastern Mediterranean

LBN	Lebanon
LBY	Libya
DJI	Djibouti
EGY	Egypt
IRN	Iran (Islamic Republic of)
IRQ	Iraq
JOR	Jordan
PAK	Pakistan
SDN	Sudan
SYR	Syrian Arab Republic
TUN	Tunisia
AFG	Afghanistan
SOM	Somalia
YEM	Yemen

EUR_LMIC Low and middle-income Europe

BGR	Bulgaria
BLR	Belarus
BLT	Baltic States
KAZ	Kazakhstan
OBN	Other Balkans
ROU	Romania
RUS	Russian Federation

ALB Albania

ARM Armenia

AZE Azerbaijan

GEO Georgia

MDA Republic of Moldova

TKM Turkmenistan

UKR Ukraine

KGZ Kyrgyzstan

TJK Tajikistan

UZB Uzbekistan

SEA_LMIC Low and middle-income South-East Asia

BTN Bhutan

IDN Indonesia

IND India

LKA Sri Lanka

THA Thailand

TLS Timor-Leste

BGD Bangladesh

MMR Myanmar

NPL Nepal

WPR_LMIC Low and middle-income Western Pacific

FJI Fiji

MYS Malaysia

OPO Other Pacific Ocean

CHM China

MNG Mongolia

PHL Philippines

PNG Papua New Guinea

VUT Vanuatu

KHM Cambodia

LAO Lao People's Democratic Republic

SLB Solomon Islands

VNM Viet Nam

A.2 Socio-economic pathways

For this study's main scenarios, we adopted a "middle-of-the-road" socioeconomic trajectory (SSP2), using GDP projections developed by the Organization for Economic Co-operation and Development (OECD) and population projections developed by the International Institute for Applied Systems Analysis (IIASA).[11,12] For analysing the sensitivity to different socio-economic pathways, we adopted two alternative socio-economic pathways in the sensitivity analysis: a "Sustainability"-termed socio-economic pathway (SSP1) which is characterized by medium to high economic growth and low population growth, and a "Fragmentation"-termed socio-economic pathway (SSP3) which is characterized by slow economic growth and high population growth.[13] The challenges to mitigation and adaptation increase when going from SSP1 to SSP3. Table A2.1 provides an overview of the storylines associated with each socio-economic pathway, and Table A2.2 lists the associated GDP and population estimates.

Table A2.1: Summary narratives of the Shared Socio-Economic Pathways (SSPs)

SSP	Narrative
SSP 1	Sustainable development is realized, with relatively high levels of investment in research and development, which leads to rapid technological change (with a sustainable focus), decreasing inequality, lower energy intensity, and high land productivity. This development pathway leads to a future where society is able to relatively easily mitigate or adapt to climate change. There is high rates of economic growth, declining population growth, and increasing levels of education globally.
SSP 2	This is a middle of the road scenario, which follows historical trends. Economic development continues, but is not uniform. Environmental degradation continues, but at a slowing pace. There is general improvement, but it is much slower than that seen in SSP 1. Climate change presents moderate challenges to both adaptation and mitigation.
SSP 3	A fairly negative future pathway characterized by increasing nationalism, with greater levels of conflict and challenges to global and regional cooperation. Barriers to trade increase, and countries tend to look inward at the expense of global cooperation. There are lower levels of technological change. Economic development is slow, and population growth is higher. Climate change presents significant challenges for both adaptation and mitigation
SSP 4	A scenario where current levels of inequality become entrenched and worsened over time. With inequality and stratification both within and between countries increasing. These leads to a world of pockets. Rich countries and elites in poorer countries improve significantly, but the rest lag behind. High levels of integration across elites allows for some level of global coordination, which allows society to more easily mitigate to climate change. However, large segment of the population are left behind, making climate change adaptation more difficult for most
SSP 5	A future characterized by fast economic industrialization. There are high levels of technological progress and improvements in education levels around the world. Globalization increases rapidly. However, the rapid industrialization is spurred on through the intense use of fossil fuels, and as such there is little effort to mitigate the effects of climate change, with the focus on adaptation through the development of new and improved technologies.

Source: Author summary from O'Neill et al 2014 and O'Neill et al 2015 descriptions of the SSPs [10,29]

Table A2.2: Regional summary of GDP (billion 2005 USD), population (million), and GDP per capita (000 USD/person) assumptions by SSP

	2010	2050				
		SSP1	SSP2	SSP3	SSP4	SSP5
East Asia and Pacific						
GDP	19,236	104,096	80,045	60,608	78,950	130,284
Population	2,184	2,173	2,261	2,351	2,145	2,187
GDP per capita	9	48	35	26	37	60
Europe						
GDP	14,628	30,571	27,780	21,342	28,442	39,228
Population	537	592	577	498	544	662
GDP per capita	27	52	48	43	52	59
Former Soviet Union (excl. Baltic States)						
GDP	2,855	10,603	8,984	7,551	9,174	13,750
Population	279	262	277	289	257	266
GDP per capita	10	40	32	26	36	52
Latin America and Caribbean						
GDP	5,834	22,838	19,164	15,894	17,600	27,492
Population	585	674	742	853	705	651
GDP per capita	10	34	26	19	25	42
Middle East and North Africa						
GDP	4,551	20,566	18,631	16,006	18,550	26,763
Population	457	646	715	808	726	649
GDP per capita	10	32	26	20	26	41
North America						
GDP	14,290	33,691	29,933	24,753	32,124	44,503
Population	344	460	450	372	424	535
GDP per capita	41	73	67	67	76	83
South Asia						
GDP	4,461	44,250	32,939	22,756	27,189	55,705
Population	1,630	2,108	2,373	2,720	2,289	2,087
GDP per capita	3	21	14	8	12	27
Sub-Saharan Africa						
GDP	1,705	19,690	13,962	9,665	8,843	25,499
Population	863	1,564	1,793	2,084	2,055	1,543
GDP per capita	2	13	8	5	4	17
World						
GDP	67,559	286,305	231,439	178,575	220,873	363,226
Population	6,879	8,479	9,187	9,975	9,147	8,578
GDP per capita	10	34	25	18	24	42

Source: Calculated from IMPACT 3.1 with population and GDP growth rates from IIASA and OECD [11,12]
Note: GDP and GDP per capita are in purchasing power parity (ppp)

A.3 Supplementary health results

Table A3.1: Health results by individual and aggregate regions

Regions	Health parameters			
	DALYs avoided ('000)	Deaths avoided ('000)	Premature deaths avoided ('000)	Years of life saved ('000)
World	75,935.31	1,695.23	994.35	53,310.13
High-income countries	1,529.25	56.86	14.25	881.04
Low and middle-income countries	74,096.16	193.56	193.56	16,493.16
Upper middle-income countries	1,776.05	31.39	20.53	1,373.78
Lower middle-income countries	56,873.44	1,345.47	750.23	39,297.77
Low-income countries	15,541.07	257.26	206.54	11,626.62
LMICs of Africa	14,840.23	210.15	189.24	12,023.94
LMICs of the Americas	513.88	-3.79	4.59	457.73
LMICs of the Eastern Mediterranean	1,113.64	6.82	12.79	852.93
LMICs of Europe	1,145.81	35.15	16.10	822.62
LMICs of Southeast Asia	37,363.10	813.41	499.26	25,989.74
LMICs of the Western Pacific	19,213.90	572.40	255.32	12,151.21
AFG	184.75	2.52	2.36	110.61
AGO	-226.82	-2.29	-2.39	-210.29
ALB	4.95	0.14	0.07	2.88
ARG	35.66	1.02	0.46	21.19
ARM	-6.83	-0.43	-0.04	-4.80
AUS	-33.92	-1.47	-0.17	-18.04
AUT	13.69	0.61	0.09	7.71
AZE	-8.39	-0.28	-0.09	-5.50
BDI	481.38	8.75	6.96	352.82
BEN	71.08	1.06	0.89	50.73
BFA	167.55	1.50	1.77	139.37
BGD	2,188.07	49.29	29.02	1,267.86
BGR	-23.85	-1.07	-0.20	-15.97
BLR	29.99	0.97	0.44	20.10
BLT	15.94	0.55	0.21	10.26
BLX	14.21	0.58	0.11	8.15
BLZ	-0.09	0.00	0.00	-0.05
BOL	41.22	-1.54	0.04	59.11
BRA	316.43	3.03	3.46	234.73
BTN	5.25	0.06	0.06	4.15
BWA	8.13	-0.01	0.12	5.29
CAF	110.57	1.58	1.53	85.67
CAN	38.65	1.58	0.27	21.93
CHL	71.81	2.34	0.75	40.23
CHM	19,009.47	575.87	253.33	12,046.60
CHP	4.23	0.17	0.03	2.16

CIV	440.02	6.42	5.27	368.54
CMR	214.30	2.25	2.45	181.53
COD	2,887.76	34.13	34.32	2,384.08
COG	238.80	2.66	2.62	208.51
COL	124.77	0.94	1.32	97.52
CRB	-18.95	-0.67	-0.22	-12.25
CRI	-2.97	-0.11	-0.02	-1.70
CUB	36.79	1.04	0.36	20.66
CYP	-0.33	-0.01	0.00	-0.19
CZE	-6.01	-0.39	0.00	-3.93
DEU	91.48	4.02	0.59	51.68
DJI	4.55	0.00	0.05	3.65
DNK	5.53	0.22	0.04	3.19
DOM	-10.70	-0.56	-0.11	-1.02
DZA	-39.49	-1.44	-0.46	-25.43
ECU	31.49	0.25	0.36	26.33
EGY	-63.04	-4.46	-0.83	-23.12
ERI	42.10	0.73	0.63	24.24
ETH	1,430.61	24.25	18.06	1,002.72
FJI	-16.06	-0.46	-0.22	-10.37
FNP	3.58	0.16	0.02	2.03
FRP	54.35	2.25	0.41	29.80
GAB	3.47	0.06	0.05	2.43
GEO	-17.24	-0.83	-0.11	-11.38
GHA	235.75	4.44	2.92	176.87
GIN	426.25	6.25	5.08	346.05
GMB	6.84	0.03	0.06	5.60
GNB	22.90	0.27	0.28	18.67
GNQ	2.77	0.04	0.03	2.36
GRC	31.41	1.28	0.23	17.11
GSA	-6.72	-0.22	-0.10	-4.35
GTM	-33.07	-0.95	-0.39	-19.61
HND	-16.42	-0.51	-0.18	-9.01
HRV	-1.40	-0.09	0.00	-0.97
HTI	-13.01	-1.07	-0.29	-6.91
HUN	8.03	0.11	0.16	4.66
IDN	2,251.80	38.71	25.45	1,622.49
IND	31,500.34	694.98	423.32	22,175.23
IRL	3.58	0.13	0.03	1.94
IRN	1.83	-0.59	0.21	-1.62
IRQ	-25.27	-2.49	-0.60	6.71
ISL	0.28	0.01	0.00	0.15
ISR	7.53	0.24	0.06	3.67
ITP	129.98	5.25	0.90	67.60
JAM	-3.11	-0.23	-0.03	-1.16
JOR	23.83	0.38	0.25	17.43
JPN	96.63	4.01	0.67	48.57

KAZ	-86.76	-3.23	-1.05	-63.60
KEN	841.89	12.45	11.12	623.98
KGZ	26.75	0.06	0.38	21.92
KHM	71.36	1.15	0.98	43.91
KOR	-111.97	-5.45	-0.43	-68.96
LAO	83.65	1.19	0.98	65.28
LBN	-24.62	-0.74	-0.23	-13.32
LBR	46.75	0.51	0.51	37.13
LBY	-4.43	-0.13	-0.04	-2.33
LKA	137.17	3.09	1.61	82.14
LSO	12.76	0.17	0.19	10.05
MDA	-7.46	-0.35	-0.04	-5.46
MDG	260.33	4.82	3.39	168.70
MEX	-165.17	-5.71	-1.90	-102.70
MLI	246.00	3.29	3.05	189.01
MMR	1,055.21	26.22	16.44	699.19
MNG	-90.40	-2.95	-1.28	-61.53
MOR	22.99	-0.53	0.27	23.60
MOZ	550.14	8.20	7.64	439.82
MRT	0.04	-0.24	-0.08	3.21
MWI	319.68	5.79	4.47	235.89
MYS	-104.84	-3.88	-1.06	-68.15
NAM	6.76	-0.08	0.07	4.13
NER	152.66	1.97	1.84	109.79
NGA	2,942.16	40.71	35.48	2,469.38
NIC	-50.81	-1.38	-0.62	-30.43
NLD	17.27	0.68	0.14	9.71
NOR	3.19	0.12	0.02	1.71
NPL	200.99	5.06	2.65	124.50
NZL	-5.82	-0.24	-0.04	-3.15
OAO	-8.79	-0.24	-0.10	-4.68
OBN	9.78	0.21	0.16	5.65
OIO	-25.29	-1.37	-0.46	-9.86
OPO		-0.02	-0.01	-0.52
OSA	15.13	0.51	0.16	8.88
PAK	429.85	3.07	5.31	298.75
PAN	-14.79	-0.51	-0.14	-8.77
PER	261.97	3.97	2.68	188.27
PHL	-105.41	-4.74	-2.12	-69.93
PNG	-42.69	-1.18	-0.82	-27.36
POL	10.31	0.12	0.23	5.75
PRT	33.74	1.18	0.29	18.14
PRY	7.49	-0.30	0.05	10.58
RAP	41.02	0.77	0.45	17.89
ROU	87.89	2.99	1.14	55.99
RUS	998.30	35.93	13.34	700.67
RWA		6.92	5.40	294.80

SAU	16.68	0.36	0.20	8.37
SDN	155.69	-0.05	1.43	149.22
SEN	144.43	1.87	1.67	102.79
SLB	-5.22	-0.13	-0.08	-3.13
SLE	69.17	1.04	0.95	56.16
SLV	4.08	-0.12	0.02	4.96
SOM	223.78	3.44	2.99	168.75
SPP	53.83	1.97	0.46	28.82
SVK	-5.78	-0.31	-0.02	-3.94
SVN	1.35	0.04	0.02	0.73
SWE	4.62	0.19	0.03	2.48
SWZ	0.48	-0.03	0.01	0.46
SYR	99.44	3.04	0.96	70.23
TCD	134.63	2.03	1.84	102.93
TGO	37.58	0.36	0.46	27.53
THA	14.21	-4.09	0.60	7.63
TJK	-41.65	-1.47	-0.59	-25.28
TKM	40.16	1.01	0.72	28.68
TLS	10.03	0.08	0.11	6.56
TUN	131.20	3.88	1.43	77.86
TUR	192.52	4.77	2.52	107.33
TZA	691.67	10.14	8.85	512.70
UGA	937.66	14.15	12.50	730.34
UKP	54.76	2.12	0.47	30.27
UKR	94.39	2.77	1.64	65.54
URY	3.15	0.09	0.04	1.84
USA	958.35	36.83	9.02	589.37
UZB	29.85	-1.82	0.13	42.93
VEN	-104.12	-3.24	-1.14	-61.98
VNM	414.04	7.55	5.62	236.35
VUT		0.00	0.00	0.04
YEM	-23.94	-1.07	-0.49	-9.90
ZAF	363.36	-0.38	2.55	339.49
ZMB	491.75	6.17	6.32	388.24
ZWE	100.42	1.21	1.37	72.15

Table A3.2: Disability-adjusted life years (DALYs) ('000) saved in 2035 compared to 2015 by risk factor and region.

Regions	All risks	Fruit and vegetable consumption	Red meat consumption	Underweight	Overweight	Obesity	Stunting
World	75,935.31	66,838.76	-12,048.34	30,522.64	-2,909.54	-26,616.43	18,760.63
High-income countries	1,529.25	2,339.56	-376.20	176.47	-39.57	-579.58	1.56
Low and middle-income countries	74,096.16	63,735.91	-11,408.30	30,306.98	-2,852.49	-25,772.00	18,712.85
Upper middle-income countries	1,776.05	4,284.84	-1,429.80	839.20	-84.83	-3,019.58	1,134.89
Lower middle-income countries	56,873.44	53,838.53	-8,796.09	16,715.58	-2,551.30	-16,228.61	12,715.54
Low-income countries	15,541.07	5,968.12	-1,303.50	12,767.59	-228.86	-6,670.26	4,861.53
LMICs of Africa	14,840.23	3,473.86	-884.70	12,088.64	3.46	-7,090.74	7,131.81
LMICs of the Americas	513.88	2,126.97	-694.88	552.90	-52.68	-2,278.16	827.63
LMICs of the Eastern Mediterranean	1,113.64	1,890.88	-779.29	1,642.03	-149.64	-2,312.24	779.59
LMICs of Europe	1,145.81	2,952.37	-848.51	144.69	-76.91	-1,218.25	152.25
LMICs of Southeast Asia	37,363.10	25,050.99	-1,221.57	13,416.35	-1,499.19	-8,492.28	9,461.63
LMICs of the Western Pacific	19,213.90	28,596.41	-7,100.44	2,477.75	-1,090.04	-4,526.76	359.05
AFG	184.75	97.55	-49.76	192.40	-15.18	-46.95	6.44
AGO	-226.82	11.75	-0.76	0.20	0.00	-0.15	-237.86
ALB	4.95	15.40	-2.34	0.96	-0.66	-8.62	0.03
ARG	35.66	115.99	-12.88	12.52	-0.84	-80.60	0.58
ARM	-6.83	24.14	-13.06	1.01	-0.91	-21.00	2.36
AUS	-33.92	10.54	-24.57	3.85	-0.48	-23.23	
AUT	13.69	10.05	4.13	0.16	-0.05	-0.58	
AZE	-8.39	0.97	-5.04	0.37	-0.21	-4.56	0.08
BDI	481.38	167.46	-7.65	337.52	-4.57	-80.55	63.68
BEN	71.08	35.03	-5.44	85.76	-2.09	-61.25	18.07
BFA	167.55	30.67	-60.78	130.34	-3.88	-59.15	130.68
BGD	2,188.07	1,382.63	-34.18	1,132.42	-41.09	-325.12	62.00
BGR	-23.85	38.67	-20.02	5.42	-3.11	-46.18	0.74
BLR	29.99	79.32	-34.16	1.51	-1.00	-16.58	-0.06
BLT	15.94	36.41	-13.56	1.37	-0.53	-8.02	-0.04
BLX	14.21	14.32	0.42	0.30	-0.05	-0.79	
BLZ	-0.09	0.57	-0.17	0.19	0.00	-0.69	0.00
BOL	41.22	40.28	-36.56	29.65	-3.19	-146.03	156.39
BRA	316.43	714.87	-268.01	162.91	-19.29	-530.96	248.90
BTN	5.25	3.84	-1.39	3.91	-0.32	-4.40	3.57
BWA	8.13	9.34	-4.99	39.39	0.27	-36.91	0.86
CAF	110.57	12.28	-12.80	142.76	3.66	-66.05	30.83
CAN	38.65	30.27	18.95	1.88	-0.24	-12.18	

CHL	71.81	138.11	-21.91	8.31	-0.06	-54.63	
CHM	19,009.47	27,478.24	-6,174.14	1,685.84	-948.26	-3,718.96	200.95
CHP	4.23	5.08	0.89	1.19	-0.21	-2.73	
CIV	440.02	136.64	-13.84	203.18	-1.73	-176.03	285.17
CMR	214.30	126.85	-17.02	268.06	1.62	-332.76	160.55
COD	2,887.76	274.57	-26.85	2,630.12	-7.02	-1,712.47	1,705.24
COG	238.80	23.22	-4.35	70.36	-0.45	-60.85	209.55
COL	124.77	186.26	-38.52	53.56	-7.71	-187.19	116.08
CRB	-18.95	7.55	-9.35	2.80	0.06	-20.19	0.13
CRI	-2.97	18.64	-6.00	3.00	-0.41	-18.56	0.12
CUB	36.79	69.31	-13.11	7.76	-1.69	-33.37	6.91
CYP	-0.33	0.16	-0.14	0.05	-0.01	-0.38	
CZE	-6.01	37.82	-25.37	2.15	-0.70	-20.85	0.51
DEU	91.48	67.13	37.28	3.44	-0.76	-15.54	
DJI	4.55	1.25	-3.06	10.28	-0.11	-7.65	3.95
DNK	5.53	4.59	1.78	0.59	-0.09	-1.34	
DOM	-10.70	46.98	-13.26	16.65	-1.69	-76.29	15.87
DZA	-39.49	75.88	-42.35	19.04	-3.58	-91.79	2.50
ECU	31.49	100.41	-20.93	15.46	-0.94	-97.34	32.21
EGY	-63.04	176.84	-243.86	23.06	0.91	-121.33	98.62
ERI	42.10	0.99	-1.85	70.14	-1.25	-19.72	-6.18
ETH	1,430.61	100.54	-5.98	1,329.07	-3.81	-308.62	317.70
FJI	-16.06	2.31	-4.66	0.76	-0.10	-14.39	0.12
FNP	3.58	4.09	0.95	0.47	-0.11	-1.82	
FRP	54.35	57.43	2.31	5.10	-0.54	-9.99	
GAB	3.47	5.91	-1.44	7.37	0.03	-9.34	0.80
GEO	-17.24	24.35	-26.70	0.95	-0.41	-17.30	1.39
GHA	235.75	184.85	-25.68	111.80	-3.27	-130.14	93.12
GIN	426.25	146.19	-19.14	189.65	-4.32	-156.29	256.90
GMB	6.84	3.13	-2.06	16.89	-0.33	-16.58	5.73
GNB	22.90	4.05	-3.04	22.52	-0.10	-13.54	12.95
GNQ	2.77	0.89	0.00	0.06	0.00	-0.06	1.87
GRC	31.41	56.07	-14.57	0.90	-0.22	-11.42	0.13
GSA	-6.72	2.61	-0.86	2.00	-0.20	-11.07	0.73
GTM	-33.07	53.26	-8.30	34.92	-0.98	-118.54	5.29
HND	-16.42	26.11	-7.74	12.30	-1.28	-48.98	2.67
HRV	-1.40	9.83	-4.14	1.82	-0.77	-8.22	0.03
HTI	-13.01	34.94	-12.90	84.78	-5.17	-132.31	16.31
HUN	8.03	47.05	-18.95	3.49	-1.35	-23.15	0.49
IDN	2,251.80	2,218.85	-201.36	1,437.31	-344.69	-1,995.22	1,050.76
IND	31,500.34	19,545.62	-416.84	9,951.05	-945.60	-5,345.12	8,211.82
IRL	3.58	5.57	0.51	0.44	-0.05	-2.90	
IRN	1.83	177.45	-74.54	28.24	-8.05	-125.48	3.08
IRQ	-25.27	44.29	-1.31	23.01	1.37	-191.13	97.15
ISL	0.28	0.45	-0.01	0.06	-0.01	-0.21	
ISR	7.53	8.30	0.54	0.33	-0.06	-1.59	
ITP	129.98	146.52	12.19	6.21	-2.12	-33.05	

JAM	-3.11	9.14	-3.09	2.73	-0.18	-16.49	4.60
JOR	23.83	45.27	-12.62	2.91	0.32	-27.68	14.54
JPN	96.63	179.74	-106.62	62.85	-11.22	-28.65	
KAZ	-86.76	84.68	-104.60	6.80	-1.25	-73.36	0.01
KEN	841.89	295.01	-32.97	884.59	2.47	-566.63	249.18
KGZ	26.75	65.31	-32.18	4.70	-2.23	-37.12	26.35
KHM	71.36	51.15	-35.25	80.84	-9.41	-25.92	9.59
KOR	-111.97	228.38	-307.49	38.99	-15.41	-59.99	
LAO	83.65	38.04	-18.67	28.99	-4.52	-11.79	50.75
LBN	-24.62	14.55	-26.34	0.88	-0.19	-14.18	0.50
LBR	46.75	25.96	-6.62	0.02	-0.74	-4.63	31.41
LBY	-4.43	14.20	-5.98	1.14	0.08	-14.12	0.11
LKA	137.17	209.60	-26.02	78.50	-28.65	-124.34	22.36
LSO	12.76	6.17	-2.19	0.00	6.38	-0.01	2.27
MDA	-7.46	30.77	-8.68	2.49	-0.88	-32.00	
MDG	260.33	99.50	-26.39	287.47	-10.53	-108.20	16.51
MEX	-165.17	178.79	-136.89	21.18	0.05	-234.89	4.86
MLI	246.00	71.24	-25.05	166.57	-4.77	-76.07	112.73
MMR	1,055.21	1,115.68	-207.50	378.20	-74.74	-220.22	31.05
MNG	-90.40	44.76	-90.57	6.32	-0.82	-60.94	11.38
MOR	22.99	120.76	-66.89	22.06	-4.71	-96.13	45.96
MOZ	550.14	50.11	-29.22	538.07	15.89	-191.99	167.13
MRT	0.04	4.88	-6.50	24.86	-0.20	-37.48	14.55
MWI	319.68	139.26	-7.11	191.44	3.62	-64.10	54.40
MYS	-104.84	68.06	-63.91	45.29	-9.64	-147.30	2.11
NAM	6.76	9.39	-6.42	39.23	-0.13	-38.16	2.66
NER	152.66	36.65	-56.28	191.34	-2.87	-59.74	43.51
NGA	2,942.16	637.96	-128.45	1,238.22	4.29	-737.41	1,911.08
NIC	-50.81	7.16	-5.07	9.95	-0.63	-64.64	2.35
NLD	17.27	19.97	1.79	2.67	-0.45	-6.73	
NOR	3.19	1.91	1.15	-0.06	0.01	0.19	
NPL	200.99	130.61	-37.49	183.58	-14.95	-67.91	4.20
NZL	-5.82	0.61	-2.66	0.59	-0.02	-4.32	
OAO	-8.79	2.89	-2.47	5.70	-0.32	-15.70	1.05
OBN	9.78	69.14	-10.67	10.11	-3.33	-56.57	0.22
OIO	-25.29	7.34	-2.62	12.52	-2.19	-70.47	29.67
OSA	15.13	19.52	-4.12	0.25	-0.14	-0.42	-0.02
PAK	429.85	563.14	-135.46	699.81	-122.50	-801.34	215.54
PAN	-14.79	11.39	-6.97	3.30	-0.17	-22.71	0.20
PER	261.97	270.25	-15.90	44.34	-4.47	-211.66	172.51
PHL	-105.41	383.99	-411.12	254.25	-83.88	-301.44	46.99
PNG	-42.69	26.57	-16.90	48.77	-0.68	-109.00	8.45
POL	10.31	123.96	-76.04	5.93	-2.68	-41.87	
PRT	33.74	40.82	0.15	1.77	-0.37	-8.75	
PRY	7.49	30.27	-18.28	8.65	-1.87	-37.62	25.76
RAP	41.02	123.40	-22.59	3.86	0.85	-65.77	
ROU	87.89	143.17	-39.86	6.79	-2.04	-22.30	0.76

RUS	998.30	1,643.05	-295.22	51.69	-22.35	-390.27	-6.54
SAU	16.68	104.95	-21.90	7.66	0.45	-75.46	
SDN	155.69	357.64	-136.40	310.16	-0.68	-611.17	220.80
SEN	144.43	34.94	-9.49	184.47	-2.26	-122.76	58.33
SLB	-5.22	1.06	-1.77	2.35	-0.15	-7.36	0.68
SLE	69.17	17.81	-2.31	58.23	-0.04	-35.59	30.61
SLV	4.08	14.16	-3.41	5.15	-0.18	-25.15	13.30
SOM	223.78	7.79	-15.18	251.01	1.01	-76.43	56.49
SPP	53.83	44.76	22.10	2.76	-0.49	-15.29	
SVK	-5.78	21.22	-10.68	1.69	-1.01	-17.46	0.26
SVN	1.35	5.91	-1.92	0.57	-0.09	-3.17	0.02
SWE	4.62	8.68	0.37	1.66	-0.38	-5.74	
SWZ	0.48	3.53	-1.99	16.06	0.17	-17.97	0.60
SYR	99.44	147.86	-21.02	9.45	-0.03	-73.52	32.68
TCD	134.63	8.16	-10.67	176.36	0.30	-68.24	28.90
TGO	37.58	12.84	-5.93	79.47	-1.13	-60.10	12.19
THA	14.21	442.55	-293.09	236.56	-47.84	-405.36	72.57
TJK	-41.65	16.62	-11.39	10.73	-5.30	-63.21	10.83
TKM	40.16	110.26	-45.70	2.87	-2.05	-28.98	0.36
TLS	10.03	1.62	-3.69	14.83	-1.30	-4.59	3.30
TUN	131.20	199.72	-39.41	5.07	-1.77	-40.48	2.49
TUR	192.52	286.96	-75.86	1.75	-0.26	-22.28	1.14
TZA	691.67	222.85	-32.02	688.12	8.51	-423.72	219.99
UGA	937.66	177.74	-29.38	629.32	4.74	-166.00	318.29
UKP	54.76	95.99	-1.93	8.60	-0.91	-47.29	
UKR	94.39	355.58	-121.08	15.38	-12.51	-146.44	-0.88
URY	3.15	13.80	-3.99	2.00	-0.19	-8.66	0.01
USA	958.35	796.92	171.32	1.46	0.05	-8.71	
UZB	29.85	214.50	-64.24	21.52	-18.14	-245.75	116.66
VEN	-104.12	43.69	-40.13	11.59	-1.59	-119.80	1.98
VNM	414.04	502.22	-283.45	324.35	-32.59	-129.68	28.03
YEM	-23.94	43.34	-14.34	84.63	-4.81	-160.79	27.22
ZAF	363.36	172.66	-174.97	252.49	0.27	-444.26	555.65
ZMB	491.75	56.21	-12.52	546.23	9.34	-309.37	199.27
ZWE	100.42	30.53	-17.12	203.61	3.49	-139.88	19.69