

## IPCC AR5 WGII

There were a number of unexplained and unjustified changes to the Intergovernmental Panel on Climate Change Chapter (IPCC) Fifth Assessment Report (AR5) Working Group II (WGII). Chapter 10 had two sections added to it after the Second Order Draft (SOD) was sent out for review: Section 10.9.2 (Aggregate Impacts) and Section 10.9.3 (Social Cost of Carbon). Additional changes were made to Section 10.9.2 after the Final Government Draft (FGD) had been disseminated for public consumption. Many of these changes were unexplained, and the explanations which were given were sometimes false. Most troubling, the changes generally promoted the work and views of Richard Tol, a person responsible for the text which was changed.

### **Section 10.9.3**

Section 10.9.3 in the FGD, Social Cost of Carbon, was derived in part from Chapter 19's SOD Section 19.6.3.5 (titled Aggregate Impacts). The first sentence of the Chapter 10 version is:

*The social cost of carbon (SCC) monetizes the expected welfare impacts of a marginal increase in carbon dioxide emissions in a given year (i.e., the welfare loss associated with an additional tonne of CO<sub>2</sub> emitted), aggregated across space, time, and probability (Tol, 2011).*

This was taken from the previous Chapter 19 version which said:

*The social cost of carbon (SCC) is an alternative index of aggregate damages that monetizes the expected welfare impacts of a marginal increase in carbon dioxide emissions in a given year (i.e., the welfare loss associated with an additional tonne of CO<sub>2</sub> emitted), aggregated across space, time, and probability (e.g., Newbold et al., 2010; Nordhaus, 2011a; Tol, 2011; Kopp and Mignone, 2012).*

The sentence was changed to remove the definition of the "social cost of carbon (SCC)." That change meant SCC was never defined in the section of the IPCC report which discussed it. Additionally, three sources were removed from the sentence, leaving only (Tol, 2011). Tol, 2011, was written by Richard Tol, one of the two Coordinating Lead Authors (CLA) for the chapter this section is in, Chapter 10,

The next few sentences are new:

*Figure 10-2 shows estimates published before AR4 and since, using the kernel density estimator by (Tol, 2013), extending the data with new estimates by (Anthoff and Tol, 2013b; Hope and Hope, 2013; Hope, 2013; Interagency Working Group on the Social Cost of Carbon, 2013). Central estimates of the social cost of carbon have fallen slightly for all pure rates of time preference and the uncertainty has tightened, particularly for studies that use a pure rate of time preference of zero. See Table 10-9. For comparison, the EU ETS price in July 2013 was about \$21/tC.*

Tol 2013, also written by CLA Richard Tol, is the source given for the methodology used to generate Figure 10-2. It is also the source given for Table 10-9. Additionally, the acronym EU ETS is never spelled out, unlike every other acronym in the chapter.

Additionally, this new text says "estimates of the social cost of carbon have fallen slightly" and "the uncertainty has tightened." These conclusions were not present in the earlier version, as Chapter 19's text said:

*Thus the risk for aggregate damages is similar to that expressed in AR4 and Smith et al., (2009) as indicated in 27 Figure 19-5, with confidence in the assessment unchanged.*

Similarly, the previous version said:

*A further source of uncertainty is whether and how the possibility of catastrophic damages is accounted for (Dietz, 2010; Nordhaus, 2011b; Weitzman, 2009), which requires bounding potential losses with a parameter akin to the value of a statistical life (representing, essentially, willingness to pay to avoid human extinction) (Dietz, 2010; Kopp et al., 2012, p.2012). Without such a parameter, SCC estimates incorporating risk aversion and potential catastrophic impacts can be unboundedly high.*

While the new version directly repudiates this by saying:

*Concerns have been raised that the uncertainty about climate change is so large that the SCC would be unbounded (Weitzman, 2009), but this result is sensitive to assumptions about the utility function (Buchholz and Schymura, 2012; Millner, 2013; Nordhaus, 2011) and disappears when climate policy is formulated as balancing the risks of climate change against those of mitigation policy (Anthoff and Tol, 2013a; Hwang et al., 2013).*

While once again relying upon work by Chapter 10 CLA Richard Tol (Anthoff and Tol, 2013a). The result is Section 10.9.3 of the final version of the IPCC WGII AR5 undermines and contradicts earlier versions of the report, based entirely upon changes made absent any sort of external review. Additionally, a figure and table were added to the section without any sort of review.

Perhaps most troubling, however, is all of these changes appear to have been made by the person whose work they were based upon, CLA Richard Tol. Tol was strongly opposed to the previous text, submitting a review comment to the Second Order Draft of the earlier version in Chapter 19 which said:

*The opening paragraphs of 19.6.3.5 are not about aggregate impacts at all. These are followed by paragraphs stating that you really should not trust these studies. This is most odd. You do not write in the same way about other literatures, even if those papers can be picked apart just as easily or even more so. It is your job to assess the literature, rather than attack it. (Tol, Richard S.J., Vrije Universiteit Amsterdam)*

## **Section 10.9.2**

The text of Section 10.9.2 in the FGD, Aggregate Impacts, was not present in any previous portion of the IPCC report. It says:

### *10.9.2. Aggregate Impacts*

*Since AR4, four new estimates of the global aggregate impact on human welfare of moderate climate change were published (Bosello et al., 2012; Maddison and Rehdanz, 2011; Roson and van der Mensbrugghe, 2012), including two estimates for warming greater than 3°C. Estimates agree on the size of the impact (small relative to economic growth) but disagree on the sign (Figure 10-1). Climate change may be beneficial for moderate climate change but turn negative for greater warming. Impacts worsen for larger warming, and estimates diverge. The new estimates have slightly widened the uncertainty about the economic impacts of climate.*

*Welfare impacts have been estimated with different methods, ranging from expert elicitation to econometric studies and simulation models. Different studies include different aspects of the impacts of*

*climate change, but no estimate is complete; most experts speculate that excluded impacts are on balance negative (Füssel, 2010; Tol, 2008; Yohe, 2008). Estimates across the studies reflect different assumptions about intersectoral, interregional and intertemporal interactions, about adaptation, and about the monetary values of impacts. Aggregate estimates of costs mask significant differences in impacts across sectors, regions, countries and populations. Relative to their income, economic impacts are higher for poorer people.*

The first sentence refers to "four new estimates." The second sentence says "[e]stimates agree on the size of impacts... but disagree on the sign." A careless reader might assume the two sentences refer to the same thing. They do not. Figure 10-1 of the FGD shows four data points as diamonds and has the caption "studies published since IPCC AR5 are highlighted as diamonds." Those four data points represent the "four new estimates" referred to in the first sentence. They all agree "on the sign" as all are negative. The only positive estimates shown in Figure 10-1 are older estimates, ones published more than a decade before the IPCC AR5 (taken from Table 10.B.1):

<i>(Mendelsohn et al. 2000)a</i>	0.1
<i>(Tol 2002)</i>	2.3

IPCC assessment reports are supposed to tell the reader what has been learned since the last report. This section pretends to by referring to estimates made since the last report. It then immediately switches focus to a conclusion supported solely by work from over a decade ago, giving no information as to what the new estimates show.

Additionally, the "a" attached to Mendelsohn et al. 2000 refers to the footnote for the table which says, "Results aggregated by (Tol 2013)." This indicates one of the two positive estimates is not actually present in the paper listed, but was later calculated by a third party based upon what that paper says. That estimate was done in Tol 2013, written by CLA Richard Tol. The other positive estimate was taken from Tol 2002, also written by CLA Richard Tol.

The result is this text, table and figure are based entirely upon work done by the person responsible for the text, text which was never subjected to any external review. Additionally, none of these results match what was said in the Second Order Draft version of the report. That version said:

*it is difficult to detect a monotonic relationship between vulnerability and aggregate risks at the global scale*

No explanation was provided for why the IPCC report's conclusions changed. No explanation was given for why conclusions had changed since previous IPCC report. No description of what changes between IPCC reports, or even versions of the latest report, was ever provided. Indeed, no description of the topic covered in the section was ever provided as the section failed to even define the subject it was discussing.

### **Changes Made to the Final Government Draft**

Section 10.9.2 in the Final Version of the IPCC AR5 WGII was changed after the Final Government Draft was disseminated to the public. These changes were not included in the change document published along with the report, but a new version of that document was published some time after listing many of them. The current version of the document does not list all the changes though, and it does not explain a number of them.

Even when it does accurately list changes, it does not accurately explain why those changes were made. The most obvious change is the Final Government Draft said:

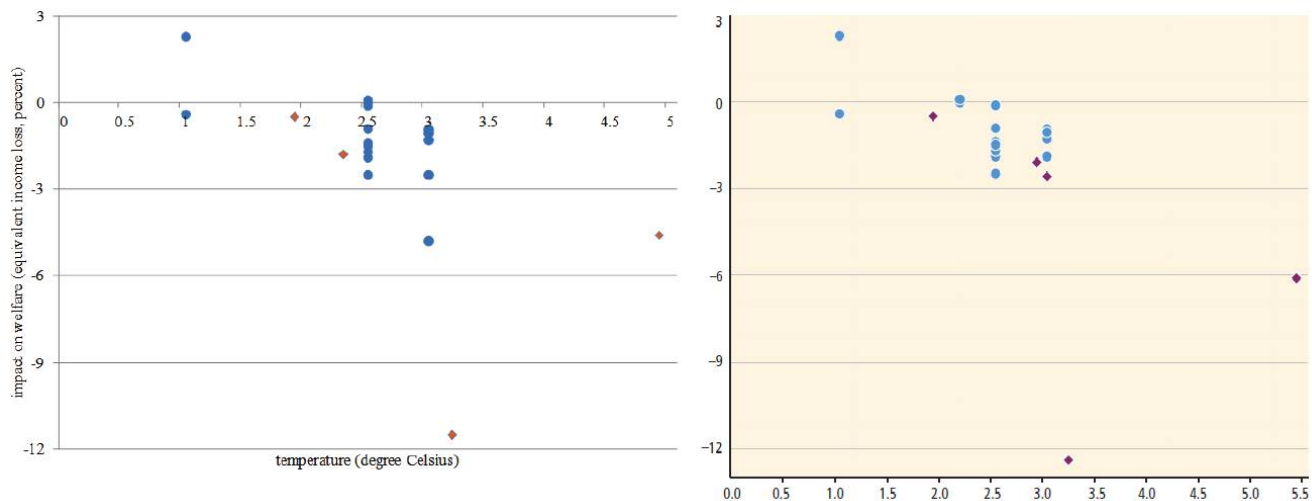
*Estimates agree on the size of the impact (small relative to economic growth) but disagree on the sign (Figure 10-1). Climate change may be beneficial for moderate climate change but turn negative for greater warming.*

While the Final Version says:

*Estimates agree on the size of impacts (small relative to economic growth), and 17 of the 20 impact estimates shown in Figure 10.1 are negative. Losses accelerate with greater warming and estimates diverge.*

This is an improvement as the original text was not supported by anything in the IPCC AR5 report. It is troubling primarily because there is no explanation as to how the earlier text was ever accepted, nor why the final change was made outside the normal IPCC review process.

While that change was accurately listed in the change document, there are many other changes to Section 10.9.2 which are not. Many of the changes can be seen by comparing the various versions of Figure 10-1 (Final Government Draft - left, Final Version - right):



The corresponding tables for these graphs enable one to examine just where these differences come from. An examination of the ~20 data points shows many inexplicable changes. For instance, the data point associated with Nordhaus (1994a) was changed from -4.8 (-30.0 to 0.0) to -1.9 (median), -3.6 (mean) [-21 to 0.0]. The change document says the numbers were "corrected to address errors found in fact check," but no further explanation is provided. The original value was taken from the wrong figure in the underlying paper, so it is good for this error was corrected, but it is peculiar both the mean and median value for this paper are provided while previously only the median value was displayed.

Another difference can be found in the entry for Hope 2006. The range given for the paper was originally listed as -0.2 to 2.7, a range which excludes the -0.9 estimate listed. This error was one of the few listed in any of the IPCC documents. Its list of substantive edits previously said:

In cell intersection Hope (2006a) row and Impact (% GDP) column, change '-0.2 to 2.7' to '-2.7 to 0.2'

But now it says:

Table 10.B.1, entry for "Hope 2006a" and "Impact, GDP (%)": Numbers corrected to address errors found in fact check.

Original numbers: "-0.9, (-0.2 to 2.7)"

New numbers: "-0.9, (-2.7 to 0.0)"

Both of these entries are described as "Results aggregated by Tol (2013)." No explanation is provided as to how two different ranges of values could be references as taken from the same paper. The paper shows:

*Table 1*  
**Corrected and Updated Estimates of the Welfare Impact of Climate Change**  
*(changed estimates in bold; previously omitted estimates in italics)*

Study	Warming (°C)	Impact (% GDP)			
		Central estimate	SD	Min	Max
<b>Estimates from papers summarized in Tol (2009)</b>					
(Nordhaus 1994b)	3.0	-1.3			
(Nordhaus 1994a) <sup>†</sup>	3.0	-3.6		-21.0	0.0
(Fankhauser 1995)	2.5	-1.4			
(Tol 1995)	2.5	-1.9			
(Nordhaus and Yang 1996)	2.5	-1.7			
<b>(Plambeck and Hope 1996)</b>	2.5	<b>-2.5<sup>a</sup></b>		-11.4	<b>-0.5</b>
(Mendelsohn et al. 2000)	2.5	0.0			
	2.5	0.1			
(Nordhaus and Boyer 2000)	2.5	-1.5			
(Tol 2002)	1.0	2.3	1.0		
(Maddison 2003)	2.5	-0.1			
(Rehdanz and Maddison 2005)	1.0	-0.4			
<b>(Hope 2006)</b>	2.5	<b>-0.9<sup>b</sup></b>		<b>-2.7<sup>b</sup></b>	<b>0.2<sup>b</sup></b>
(Nordhaus 2006)	2.5	-0.9	0.1		
	3.0 <sup>c</sup>	-1.1 <sup>c</sup>	0.1 <sup>c</sup>		
(Nordhaus 2008) <sup>c</sup>	3.0 <sup>c</sup>	-2.5 <sup>c</sup>			
<b>New estimates that appeared after Tol (2009)</b>					
(Maddison and Rehdanz 2011) <sup>d</sup>	3.2	-11.5			
(Bosello et al. 2012) <sup>d</sup>	1.9	-0.5			
(Roson and van der Mensbrugghe 2012) <sup>d</sup>	2.9	-1.8			
	5.4	-4.6			
(Nordhaus 2013) <sup>d</sup>	2.9	-2.0			

The range for Hope 2006 as -2.7 to 0.2. The new version of the IPCC table does not match the published values of the paper it cites.

This is also true for several other entries in that table. The Maddison and Rehdanz 2011 paper was previously listed as providing an estimate of -11.5% economic damage for 3.2°C degrees of warming. That value was changed to -12.4%. The Roson and van der Mensbrugghe 2012 was previously listed as -1.8% economic damage for 2.3°C of warming and -4.6% for 4.9°C of warming. These values were changed to -2.1% damage for 2.9°C and -6.1% for 5.4°C.

These changes were listed in the change document as corrections "to address errors found in fact check." However, there is no explanation as to what the "errors" were. The Roson and van der Mensbrugghe 2012 paper states:

*According to our preliminary estimates, at the global level, the most serious consequence from climate change will be changes to labor productivity that would induce 84% of the global damage in 2050 (-1.8% of global GDP) and 76% in 2100 (-4.6% of global GDP).*

It would appear the IPCC report changed 1.8 to 2.1 because 1.8 is 84% of 2.1. Similarly, it would appear 4.6 was changed to 6.1 because 4.6 is 76% of 6.1. This is wrong. The values in parentheses are the total damage, not the damage caused solely by changes to labor productivity. It appears the changes to the values for this paper were made to fix a problem which didn't actually exist. The same is true for the change in temperature values (from 2.3°C to 2.9°C and 4.9°C to 5.4°C), which also have no basis in the paper cited by the IPCC report.

The change for the Hope 2006 values is no more explicable. The range was changed from -0.2 to -2.7 to -2.7 to 0.0. The IPCC claims this change is because of "errors found in fact check," but their no explanation as to where the new values come from. The values are cited as being taken from Tol 2013, but that paper clearly lists the previous value, not the one listed in the Final Version of the IPCC AR5.

The Supplementary Material for the IPCC AR5 provides calculations for this value. Hope 2006 estimated damages to the European Union. The IPCC then multiplied the %damage by different scaling factors for different parts of the globe to get a %impact for each area. It then multiplies that by each area's total GDP to get an estimate of the total impact for that area. Having done that, the IPCC adds up the results for each area and divides by the total GDP, generating the table:

Area	Damage to EU	GDP	Scaling Factor	Impact
European Union	1.23%	13705	1.00	168.57
USA		13095	0.25	40.27
OECD except EU and USA		7358	0.25	22.63
Former Soviet Union and Eastern Europe		1919	-0.35	-8.26
China and Centrally Planned Asia		2453	0.20	6.03
India and Southeast Asia		1958	2.50	60.19
Africa and the Middle East		2579	1.83	58.04
Latin America		2836	1.83	63.83
Sum:		45900.99		411.29

%Economic Damage: 0.9

A problem arises in the values for the GDP column. The IPCC Supplementary Material lists them as from "GDP (World Bank)" for the year 2005. It's not clear why those particular values are used, but it is troubling as Hope 2006 published the values it used in its own calculations:

Regions & baseyear:	Area:	GDP	CO2 emit	CH4 emit	SF6 emit	S emit	Natural S	RT	
EU	EU	3.79E+06	8.76E+06	3472	25	0.001	6.1	7.00E-08	0.4 (Focus region)
FSU & E.Eur	EE	2.36E+07	2.63E+06	3032	39	0.001	11.0	7.00E-08	0.8
USA	US	9.36E+06	9.64E+06	5812	25	0.001	8.3	7.00E-08	0.4
China & CP Asia	CA	1.17E+07	5.26E+06	3410	63	0.0005	21.0	7.00E-08	0.2
India & SE Asia	IA	8.90E+06	4.38E+06	5606	63	0.0005	4.3	7.00E-08	0.4
Africa & ME	AF	3.63E+07	3.07E+06	3142	43	0.0005	7.7	7.00E-08	0.4
Latin America	LA	2.05E+07	3.50E+06	2680	43	0.0005	5.1	7.00E-08	0.4
Other OECD	OT	1.42E+07	6.57E+06	2292	25	0.001	2.6	7.00E-08	0.8
		Km2	\$million	Mtonnes	Mtonnes	Mtonnes	TgS	Tg/Km2	degC

The values in Hope 2006's GDP column are significantly different from those used by the IPCC. There is no explanation as to why the IPCC ignored the GDP values used by Hope 2006 and used a different set of values. The values used by Hope 2006 give a central value of -1% and an uncertainty range of 0 to -3.3%. The values used by the IPCC report give a central value of -0.9% and an uncertainty range of 0 to -2.7%. The results given in Tol 2013, which the IPCC AR5 cites for its values, showed a central value of -0.9% with an uncertainty range of -0.2% to -2.7%. No explanation is provided as to why these values are different.

Interestingly, the IPCC's Supplementary Material shows the exact same economic data was used in its calculations for Plambeck and Hope 1996, a paper published a decade prior to the year that data was generated for. No explanation is provided as to why the IPCC uses data from 2005 to estimate results for a paper published in 1996.

Another estimate, for Maddison and Rehdanz (2011), is claimed to have been taken from Tol (2013) like the last two. This citation was given for both the FGD and Final Version of the IPCC AR5 even though the FGD lists its value as -11.5% while the Final Versions lists it as -12.4%. Tol (2013) lists the former value. No explanation is provided by the IPCC as to why it cites a paper for a value not present in that paper.

Moreover, the IPCC's Supplementary Material for this estimate shows it uses "GDP/cap (PPP) (CIA World Fact Book)." PPP stands for "purchasing power parity." Purchasing power parity is a different type of GDP than is that used in the rest of the estimates shown in Section 10.9.2 (called "nominal GDP"). Had nominal GDP been used instead of PPP GDP, the estimate given as -11.5% in the FGD and -12.4% in the Final Version would have only been -4.7% (using the same 2005 World Bank data).

All of these values cite sources which do give values different than those used by the IPCC. Many of them cite Tol (2013) as their source while providing calculations in the Supplementary Material which do not match the results given by Tol (2013). In effect, all of these values are new results published by the IPCC which falsely claims to take them from other sources.

To make matters more problematic, the source falsely cited by the IPCC report (Tol 2013) for a number of these values was written by CLA Richard Tol, a person responsible for the IPCC section which falsely cites said source. The result is CLA Richard Tol has published new calculations in the IPCC report while falsely attributing them to his earlier work.

The IPCC has acknowledged the changes in these values, but it falsely claims they were made to "address errors found in fact check." The reality is some of the "corrections" were errant, and others

were simply inexplicable changes that are neither right nor wrong.