The Global Resource Balance Table, an integrated table of energy, materials and the environment

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[Excerpt]

This paper introduces the Global Resource Balance Table (GRBT), which is an extension of the energy balance tables that expresses the relationships between energy, materials and the environment. The material division of the GRBT includes steel, cement, paper, wood and grain. In contrast, the environmental division of the GRBT includes oxygen, CO2 and methane. The transaction division rows in the GRBT include production, conversion, end use and stock. Each cell of the GRBT contains the quantities of the respective resources that were generated or consumed. The relationships between the cells were constructed from the laws of conservation of the materials and energy. We constructed a GRBT for 2007 and discussed the increasing air temperature due to waste heat and the CO2 equivalent from human breathing.

Table 1 Global Resource Balance Table for 2007
CO2(1):fossil fuel origin, CO2(2):biological origin

2007		Environment (Mton)				Energy (MTOE)								Materials (Mton)				
Global	Transaction	CO2(1)	CO2(2)	O2	CH4	Oil	Coal	Gas	Nuclear	Hydro	Fuel Wood	Electricity	Waste Heat	Steel	Cement	Paper	Wood	Grain
Production	Extraction	0	0	0	202	4,078	3,190	2,528	709	264	0	0	0	Iron Ore 950	Limestone 3,780	0	1,796	0
	Recycle	0	−7,021	5,106	0	0	0	0	0	0	0	0	0	405	0	166	0	0
Conversion	Electricity	12,527	0	−9,111	0	−893	−1,867	−1,432	−709	−264	0	1,979	3,186	0	0	0	0	0
	Conversion	1,211	0	−881	90	−255	−132	0	0	0	943	0	387	0	0	0	−943	0
Material Production	Steel	1,243	0	−904	0	−17	−325	0	0	0	0	−70	403	1,350	0	0	0	0
	Cement	887	0	−645	0	−38	−212	0	0	0	0	−34	279	0	2,560	0	0	0
	Paper	584	28	−445	0	−27	−138	0	0	0	−31	−37	197	0	0	556	−390	0
End Use	Agriculture	0	0	0	72	0	0	0	0	0	0	0	0	0	0	0	0	2,351
	Human	0	2,524	−1,836	0	0	0	0	0	0	0	0	0	0	0	0	0	−1,728
	Livestock	0	3,133	−2,279	84	0	0	0	0	0	0	0	0	0	0	0	0	−623
	Industry	2,741	423	−2,301	0	−341	−236	−414	0	0	−280	−818	1,700	−945	−2,560	−185	−463	0
	Commercial	2,050	366	−1,757	0	−289	−125	−352	0	0	−190	−371	1,088	0	0	−212	0	0
	Residential	2,526	547	−2,235	0	−434	−155	−330	0	0	−442	−557	1,402	0	0	−159	0	0
	Transport	5,082	0	−3,696	0	−1,784	0	0	0	0	0	−92	1,864	0	0	0	0	0
Stock	Stock	28,851	7,021	−26,089	448	−4,078	−3,190	−2,528	−709	0	0	0	10,504	0	0	0	−1,796	0
	Recycle	0	−7,021	5,106	0	0	0	0	0	0	0	0	0	405	0	166	0	0

Although we only picked resources that are used in large quantities, the GRBT provides a simple summary of global resource use. This table has inspired us to consider waste heat and CO2 emissions from human respiration. In addition, it shows that direct heating from waste heat caused by burning fossil fuels is significant. We estimated that the air temperature would have increased by 2.856 K in the last 120 years if all of the waste heat was absorbed by the atmosphere. CO2 emissions from human respiration indicated that each human is allocated eleven slaves of CO2 equivalents to enjoy a modern life. The GRBT is an integrated table of human resource use and can be effectively used in energy and environmental studies.

Figure 1. Consumptions and emissions in the GRBT for 2007 (Gton/y)
(Emissions are indicated by hatched bars.)