

The estimated carbon exchange inventory of the entire world, excluding agriculture

revised:

2-Apr-11

Agriculture is not included because all of the carbon used by agriculture is inside the carbon cycle

example- a cow eats hay. The carbon in the hay comes from the CO₂ in the air. All of the carbon in the cow comes from the carbon that it eats.

All of the carbon in the cow sooner or later goes back into the air. The cow cannot put more carbon into the atmosphere than it takes out.

we also need a definition of the word forest. Ref 70 from the United nations food and agriculture organization has discussions of the different definitions of the word forest

a forest may be land with 10 to 30 % trees or more, may include tree plantations, orchards

heights of trees may be from 2 meters to 7 meters, , minimum area may be .5 hectare or 1 hectare, urban trees may be included

in this reference, it says that 19 countries have reported their definitions of forests. And more countries must decide on their forest definition.

The numbers for forest area in the following...the definitions for forests in the different countries may be different

We can always do more research to improve on the numbers below,

But will we ever be able to truly pinpoint a number for how much land in the world is covered by forests?

It changes every year. In some countries the area of the forests increases, in some, it decreases.(ref 71)

The important thing is to try to get an estimation, based in reality, to help guide us

to make intelligent decisions in the future.

I. world consumption of oil, natural gas and coal

A. world oil consumption

references:

barrels per day(most numbers are for 2009, one is for 2010)

total= 82,649,870 barrels of oil consumed per day reference 38 ww.cia.gov

1 metric ton= 1000 kilograms

1 short ton = 0.90718474 metric ton

oil consumption= 83 million barrels per day ref 38

carbon content of crude oil= 85 per cent 2 <http://www.eia.doe.gov/oiaf/1605/a>

density of crude oil= 0.87 2 <http://www.eia.doe.gov/oiaf/1605/a>

| | |
|----------------------------|------------------|
| 1 barrel= 42 gallons= | 159 liters |
| 1 barrel of water weighs= | 159 kilograms |
| 1 barrel of oil weighs= | 138.33 kilograms |
| carbon in 1 barrel of oil= | 117.6 kilograms |

carbon content in one day's consumption of oil= 9,718,013,040 kilograms of carbon

carbon content in one day's consumption of oil= 9,718,013 metric tons of carbon per day

carbon content in one day's consumption of oil= **9.7 million metric tonnes of carbon per day**



B Coal annual consumption for the world

coal consumption
annual in the world(assume that production= consumption)

| | | | | |
|--|----------------------------|--------|--|---|
| hard coal(mostly bituminous) 2008 | 5794 million metric tonnes | ref 54 | ref 42 | ref 40 |
| brown coal (lignite, subbituminous),2008 | 965 million metric tonnes | | 42 http://www.britannica.com/E | 40 www.worldcoal.org |
| <u>percent carbon in coal, for the different types of coal,=</u> | | | | |
| lignite= | 30 percent carbon | | 4 | 30%=MEDIAN VALUE, www.ket.o |
| subbituminous= | 40 percent carbon | | 4 | 40%=MEDIAN VALUE, www.ket.o |
| bituminous= | 65 percent carbon | | 4 | 65%=MEDIAN VALUE, www.ket.o |

anthracite=

91 percent carbon

4 91%=MEDIAN VALUE, www.ket.o

hard coal is 65% carbon, so if all of this coal is burned, 65% of its weight is emitted as carbon:
hard coal estimated annual carbon emissions=

3766 million metric tonnes carbon per year

10 million metric tonnes carbon per day

brown coal, if we average the carbon content of the
2 types of coal in brown coal, the average=

36 percent carbon

(this is an estim ref 53-

then, when brown coal is burned, the carbon that is emitted
weigh 36 percent of the beginning weight=

347 million metric tonnes of carbon per year

1 million metric tonnes carbon per day

total carbon emission for hard and soft coal, worldwide=

11 million metric tonnes carbon per day



C world natural gas consumption:

reference:

2009 est

2,940.40 billion cubic meters

39 <http://www.bp.com/sectiongenericarticle.do?>

daily consumption=

8.06 billion cubic meters

carbon content of
1 cubic meter of natural gas=

0.49 kilogram carbon

7 <http://bioenergy.ornl.gov/papers/misc/energ>

carbon content of one day's
consumption of natural gas=

3.95 billion kilograms

carbon content of one day's
consumption of natural gas=

3947.39 million kilograms

carbon content of one day's
consumption of natural gas=

3,947,386,301 kilograms

carbon content of one day's
consumption of natural gas=

3,947,386 metric tons of carbon per day

4 million metric tonnes of carbon per day

D. world-

total estimated daily production of
carbon from the consumption of
oil, gas and coal =

25 million metric tons of carbon per day

IV. world forest absorption of Co2



there are 3 kinds of forests in the world:

tropical forest,

temperate forests, boreal forests or taiga

tropical forest,, carbon absorption:

22 tonnes

CO2 per hectare per year

ref 68

5.94 tonnes

carbon per hectare per year

5,940 kilograms

carbon per hectare per year

2,405 kilograms

carbon per acre per year

temperate forests, carbon absorption:

amount of carbon absorbed by
an acre of forest in a year=
(a north america forest)

3,500 lbs per acre per year

references:

10 ny times june 8 1993, A For

1 pound =

0.45 kilograms

amount of carbon absorbed by
an acre of forest in a year=
(a north america forest)

1,588 kilograms per acre per year

boreal forests, carbon absorbtion=

47 grams carbon per square meter per day during the growing season of 115 days

reference 69

1 acre=

4,047 square meters

boreal forests, carbon absorbtion=

190,202 grams per acre per growing season

190 kilograms per acre per growing season(per year)

area of forests in the world=

4,000,000,000 hectares

ref 52

fao world forest area

1 hectare (ha) = 10 000 square meters (m²) = 0.01 square kilometres (km²)

there are 3 kinds of forests in the world:

| | | | | |
|----------------------|---------------------------------------|-----------------------------------|--------|---|
| tropical forest | <u>latitudes:</u> 23.5 N to 23.5 s | <u>growing season</u> all year | ref 50 | the forest biome, univ of calif, museum of paleontology |
| temperate forests | 24 to 49 n&S | 140 to 200 days | ref 50 | |
| boreal forests,taiga | 50 to 60 degrees n | 130 days | ref 50 | |

| Region/subregion | Forest area (1 000 ha) | % of land area | <u>latitudes</u> | percent* tropical forest | percent* temperate forest | percent* boreal/taiga forest |
|--|---------------------------|----------------|------------------|--------------------------------|---------------------------------|--|
| | ref 53 | ref 53 | | | | |
| Eastern and Southern Africa | | 226,534 | 5.73 | 0deg to 35 deg s | 3 | 2.73 |
| Northern Africa | 131 048 | | 3.32 | 0 deg to 36n | 2 | 1.32 |
| Western and Central Africa | 277 829 | | 7.03 | 0 deg to 36n | 4 | 3.03 |
| Total Africa | 635 412 | | 16.08 | | | |
| East Asia | 244 862 | | 6.2 | 19n to 48 n | | 6.2 |
| South and Southeast Asia | 283 127 | | 7.16 | 0 deg to 24n | 7.16 | |
| Western and Central Asia | 43 588 | | 1.1 | 8n to 40 n | 1.1 | |
| Total Asia | 571 577 | | 14.46 | 0n to 49 n | | |
| Total Europe | 1 001 394 | | 25.34 | 37 n to 68 n | | 20 5.34 |
| Caribbean | 5 974 | | 0.15 | 12 n to 22 n | 0.15 | |
| Central America | 22 411 | | 0.57 | 6 n to 14 n | 0.57 | |
| North America | 677 464 | | 17.14 | 14 n to 70n | | 14 3.14 |
| Total North and Central America | 705 849 | | 17.86 | | | |
| Total Oceania | 206 254 | | 5.22 | 9n to 38s | 5.22 | |
| Total South America | 831 540 | | 21.04 | 12n to 53s | 10 | 10 1.04 |
| WORLD | 3 952 025 | | 100 | totals= | <u>33.2</u> | <u>57.28</u> <u>9.52</u> |

* I divided land areas into types of forests by estimation and this could be refined

| <u>percent*</u> <u>tropical</u> <u>forest</u> | <u>percent*</u> <u>temperate</u> <u>forest</u> | <u>percent*</u> <u>boreal/taiga</u> <u>forest</u> |
|---|--|---|
| 33.2 | 57.28 | 9.52 |

area of forests in the world= 4,000,000,000 hectares ref 52 fao world forest area

| | <u>world area of</u> <u>tropical</u> <u>forest</u> <u>hectares</u> | <u>world area of</u> <u>temperate</u> <u>forest</u> <u>hectares</u> | <u>world area of</u> <u>boreal/taiga</u> <u>forest</u> <u>hectares</u> | <u>total</u> |
|------------|---|--|---|---------------|
| hectares== | 1,328,000,000 | 2,291,200,000 | 380,800,000 | 4,000,000,000 |
| acres== | 3,281,559,460 | 5,661,678,489 | 940,977,291 | 9,884,215,240 |

1 hectare = 2.471054 acres

| | | | | |
|--|-------|-------|-----|------------------------------------|
| kilograms carbon absorbed per acre per year= | 2,405 | 1,588 | 190 | kilograms carbon per acre per year |
|--|-------|-------|-----|------------------------------------|

| | <u>tropical</u> | <u>temperate</u> | <u>boreal/taiga</u> | |
|---|-----------------|------------------|---------------------|---------------------------|
| kilograms carbon absorbed per year= | 7.89169E+12 | 8.98833E+12 | 1.78976E+11 | kilograms carbon per year |
| metric tonnes carbon absorbed per year= | 7,891,685,502 | 8,988,329,575 | 178,975,981 | |

million
metric
tonnes
carbon
absorbed
per year=

| | | | |
|-------|-------|-----|--|
| 7,892 | 8,988 | 179 | <u>total:</u> <u>17,059</u> |
|-------|-------|-----|--|

**million
metric
tonnes
carbon
absorbed
per day=**

| | | | |
|-----------|-----------|-------------|---|
| 22 | 25 | 0.49 | <u>47</u> million metric tonnes carbon absorbed per day by all the forests of the world |
|-----------|-----------|-------------|---|



VII forest fires in the world

references:

40,000,000 hectares of land burned annually

ref 52

109,589 hectares of land burned daily

1 square kilometer= 100 hectares

1,096 square kilometers of land burned daily

CO2 emitted from wildfires=

10 tons per sq kilometre ref 44

co2 emissions from wild fires in the US, present status and future

1 short ton=

0.90718474 metric tonne

USDA, Auburn Univ., George mason Univ.

CO2 emitted from wildfires=

9 metric tons per sq kilometer

the weight of carbon is

27 percent of the weight of co2
(atomic weights+C=12, O= 16, O2=32),

carbon emitted from wildfires=

2.45 metric tons per sq kilometer

1,096 square kilometers of land burned (ref 52

TOTAL CARBON EMITTED
WORLDWIDE FROM
WILDFIRES DAILY=

2,684 METRIC TONNES OF CARBON

0.003 MILLION METRIC TONNES OF CARBON

* this number of 10 tons was estimated for wild fires in the US, it may or may not be a good estimate for co2 emissions for wild fires around the world but I will use it until we get better numbers, from additional references

the reference estimates 10 tons per square kilometer. I believe this to be short tons(2000lbs), not metric tonnes(10000 kilograms), so I converted to metric tonnes

VII

World Carbon emissions from solid waste:

Solid waste is different in different countries, different regions, different economies. In reference 46, I found an analysis of solid waste in low income asian countries. This solid waste is different in composition of the solid waste in the USA, (reference 67). I will try to estimate carbon emissions from solid waste for the world, I will use the reference 45 numbers for the USA, Canada, Europe, Australia

I will use the reference 46 numbers for Asia, Africa, Latin America

in this analysis I will not try to estimate the carbon emissions from the following:

glass and metals- there will be carbon emissions when these items are manufactured, if the factories use fossil fuels- but these fossil fuels are already counted when we calculate the carbon emissions from all of the fossil fuels

plastics- plastics are made from oil, and the carbon from the oil has already been counted in the total oil

**yard trimmings- I will not count the carbon in the yard trimming because of the same reason I will not count the carbon in agricultural products all agricultural products get their carbon from the air, and when the food is eaten, or the food scraps get burned in an incinerator, or the food scraps biodegrade, the carbon goes back into the air, therefore, no net significant carbon change in the atmosphere.
(the purpose of this exercise is to try to determine if the burning of fossil fuels can create extra carbon dioxide in the atmosphere)**

food scraps

rubber, leather, textiles

I will, however, try to estimate possible carbon emissions from paper and wood.

The reference 46 numbers do not have a number for wood, so I will estimate by using a proportional number to ref 67, the same proportion as the paper waste in both references.

reference 46, table 2, average waste composition in urban settings, low income asian countries, percent of wet weight:

| <u>city or country:</u> | <u>biodegradable</u> | <u>paper</u> | <u>plastic</u> | <u>glass</u> | <u>metal</u> | <u>textiles and leather</u> | <u>inerts (sh,earth) & others</u> |
|-------------------------|----------------------|--------------|----------------|--------------|--------------|-----------------------------|---------------------------------------|
| <u>Indonesia</u> | 74 | 10 | 8 | 2 | 2 | 2 | 2 |
| <u>Dhaka</u> | 70 | 4.3 | 5 | 0.3 | 0.1 | 4.6 | 16 |
| <u>Kathmandu</u> | 68 | 9 | 11 | 3 | 0.9 | 3.9 | 5.3 |
| <u>Bangkok</u> | 53 | 9 | 19 | | 1 | 7 | 8 |
| <u>Hanoi</u> | 50 | 4.2 | 5.5 | | 2.5 | | 37.7 |
| <u>Mania</u> | 49 | 19 | 17 | | 6 | | 9 |
| <u>India</u> | 42 | 6 | 4 | 2 | 2 | 4 | 40 |
| <u>Karachi</u> | 39 | 10 | 7 | 2 | 1 | 9 | 32 |
| <u>averages</u> | 55.6 | 8.9 | 9.6 | 1.2 | 1.9 | 3.8 | 18.8 |



| <u>solid waste includes the following:</u> | <u>ref 67 municipal solid waste in the USA: percent</u> | <u>ref 46 urban solid waste low income asian countries percent</u> | <u>ref 67</u> | <u>"Municipal Solid Waste in the United States ref 46, see table 2, page 5, average of the numbers for 8 locations</u> |
|--|---|--|--------------------------|--|
| <u>paper</u> | <u>32.7%</u> | <u>8.90%</u> | | |
| glass | 5.3% | 1.20% | | |
| metals | 8.2% | 1.90% | | |
| plastics | 12.1% | 9.60% | | |
| rubber, leather, textiles | 7.6% | 3.80% | | |
| <u>wood</u> | <u>5.6%</u> | <u>1.50%</u> | <u>estimate percent*</u> | |
| yard trimmings | 12.8% | ? | | |
| food scraps | 12.5% | ? | | |
| other | 3.2% | 18.80% | | |
| biodegradable | ? | 55.60% | | |
| total paper and wood= | 38.30% | 10.40% | | |

from the above comparison, we see that in the US, there is more waste paper.
for the low income asian areas, we do not have a number for the percent of wood waste
It may be included in the biodegradable number
the asian amount of waste paper is 27 per cent of the USA waste paper
* in the us, the wood waste percent is 27% of the paper waste percent

* I will use this 27 % to estimate an amount of waste wood in asia waste compared to the amount of wood waste in the US

| <u>country or continent:</u> | <u>population reference 68</u> | <u>kilograms solid waste per person per day references 49,46,45</u> | <u>total% wood and paper (estimated refs 67 ,42)</u> | <u>kilograms per person per day for wood and paper</u> | <u>total kgs per day for wood and paper</u> |
|------------------------------|--------------------------------|---|--|--|---|
| Asia | 4,119,626,293 | 0.68 | 10.4 | 0.07072 | 291,339,971 |
| Africa | 1,012,956,064 | 0.78 | 10.4 | 0.08112 | 82,170,996 |
| Northern America | 344,124,520 | 2.1 | 38.3 | 0.8043 | 276,779,351 |
| South America | 396,391,032 | 0.8 | 10.4 | 0.0832 | 32,979,734 |
| Central America | 154,298,120 | 0.8 | 10.4 | 0.0832 | 12,837,604 |
| Europe | 727,082,222 | 1.52 | 38.3 | 0.58216 | 423,278,186 |
| Oceania* | 35,104,756 | 1.9 | 38.3 | 0.7277 | 25,545,731 |
| world | 6,789,583,007 | | | | 1,144,931,574 kgs per day wood and paper |

* for Oceania, used the number for Australia from ref 45

1,144,932 metric tons per day wood and paper

1.14 million metric tons per day wood and paper

the formula for cellulose is (C6 H10 O5)n
 and carbon is 35% of the weight
 of cellulose
 therefore we will multiply the above number by 35%
 to find the amount of carbon in paper and wood
 this carbon will be release to the atmosphere if the wood and paper
 is burned or it biodegrades:

0.40 million metric tons of carbon per day
 in the wood and paper waste
 for the entire world(estimated)
 this carbon can go into the atmosphere

from ref 46, table 2

| <u>country</u> | <u>waste generation</u> <u>kg/capita/day</u> (for some countries, the reference has a range, i.e..2 to .5, for these numbers, I will use an average) | |
|----------------|---|-------------------|
| nepal | 0.35 | |
| cambodia | 1 | |
| Lao PDR | 0.7 | |
| Bangladesh | 0.5 | |
| Vietnam | 0.55 | |
| Pakistan | 0.7 | |
| India | 0.45 | |
| Indonesia | 0.9 | |
| China | 0.8 | |
| Sri Lanka | 0.55 | |
| Phillippines | 0.5 | |
| Thailand | <u>1.1</u> | |
| average= | 0.68 | use this for asia |



from ref 48 waste per
person per day in Africa

from table 1 pages 10 and 11:

Country

kilograms waste per person per
day:

| | |
|-----------------|------|
| Benin | 0.5 |
| Burkina Faso | 0.7 |
| Burindi | 1.4 |
| Cameroon | 0.75 |
| Congo DR | 1.2 |
| Congo Rep | 0.6 |
| Egypt | 0.5 |
| Gambia | 0.4 |
| Ghana | 0.4 |
| Guinea | 0.7 |
| Mauritania | 0.9 |
| Morocco | 0.6 |
| Namibia | 0.7 |
| Niger | 1 |
| Nigeria | 0.7 |
| Senegal | 0.7 |
| Tanzania | 1 |
| Togo | 1.9 |
| Tunisia | 0.5 |
| Uganda | 0.6 |
| Zimbabwe | 0.7 |
| africa average= | 0.78 |

from reference 45 ,
municipal waste per person per year for the european countries on
this list:

| | | |
|-------------------|------------|--------------------------------------|
| denmark | 660 | kg/person/year |
| switzerland | 650 | |
| norway | 620 | |
| netherlands | 610 | |
| austria | 560 | |
| uk | 560 | |
| ireland | 560 | |
| belgium | 550 | |
| germany | 540 | |
| france | 510 | |
| italy | 500 | |
| finland | 460 | |
| <u>sweden</u> | <u>450</u> | |
| average of above= | 556 | kg/person/year |
| average of above= | 1.52 | kg/person/day use this for europe |

carbon in plastics are counted already because plastic is made from oil and oil is counted
food waste is not included because agriculture is not included
carbon used to produce metal and glass is in the oil, already counted
metal and glass do not contain carbon

This estimation assumes that all of the paper and wood that go into a landfill are broken down into carbon in the same year. This does not happen, but, the paper and wood from previous years that is still breaking down this year this can let us use the estimation of counting just this years paper and wood

VIII **Carbon emissions from volcanoes:**

world wide CO2 emissions from volcaoes
estimate=

200 million tons annually(short tons)

28 www.the-dailygreen.com/ptint-this/environm

total global release also estimated=

3-4x10E12 mol/yr

29 terrence-gerlach.com, 1991

a mole of co2 weighs:

48 grams

4x 10E12=

4,000,000,000,000

4x 10E12 x 48 grams=

192,000,000,000,000.00 grams

total co2 annual
release from volcanoes world wide

total co2 annual release
from volcanoes world wide=

192,000,000,000 kilograms

=

422,400,000,000 pounds

=

211,200,000 short tons

total co2 annual release
from volcanoes world wide=

192,000,000 metric tonnes

total carbon from co2 annual release
from volcanoes world wide=

51,840,000 metric tonnes

52 million metric tonnes annually

0.14 million metric tonnes daily

| | | | |
|--|---|--------|--------|
| <u>russia</u> | 3,000,000 sq kilometers | ref 56 | |
| <u>finland=</u> | 25 percent inside the arctic circle | | ref 59 |
| <u>finland total area</u> | 337,030 sq kilometers | ref 60 | |
| <u>finland tundra area</u> | 84,258 sq kilometers | | |
| <u>sweden=</u> | 14 percent inside the arctic circle | | ref 61 |
| <u>sweden total area=</u> | 449,966 sq kilometers | | ref 61 |
| <u>sweden tundra area=</u> | 62,995 sq kilometers | | |
| <u>norway's tundra=</u> | 32 percent of total | ref 57 | |
| <u>norway's total land area=</u> | 307,860 sq kilometers | ref 57 | |
| <u>norway's tundra area=</u> | 98,515 sq kilometers | | |
| <u>iceland=</u> | 100,250 sq kilometers | ref 62 | |
| <u>greenland, tundra=</u> | 1,000,000 sq kilometers | ref 62 | |
| <u>tundra area of the world=</u> | 6,000,518 sq kilometers | | |
| <u>carbon absorbtion by the tundra of the world=</u> | 1,578,218 metric tonnes carbon per day | | |
| <u>carbon absorbtion by the tundra of the world=</u> | 1.58 million metric tonnes carbon per day | | |

*Carbon emissions from the consumption of Oil,
Natural Gas, and coal in the world=*

-25 million metric tonnes of carbon per day from the bi

carbon emissions from forest fires in the world=

-0.003 million metric tonnes of carbon per day from forest fires

world wide carbon emissions from solid waste=

-0.40 million metric tonnes of carbon per day from solid waste

world wide total carbon from volcanos

-0.14 million metric tonnes of carbon per day from volcanoes

Carbon absorbed by the forests in the world=

47 million metric tonnes of carbon per day absorbed by the fore

*carbon absorbtion by the
tundra of the world=*

1.58 million metric tonnes carbon per day

estimated balance=

22.84 million metric tonnes of carbon per day

Carbon that is lost by the ecosystems(and enters the atmosphere) is a negative number and carbon that is gained by the ecosystems is a positive number