Global Deforestation Report (1990-2016)

ForestQuery is on a mission to combat deforestation around the world and to raise awareness about this topic and its impact on the environment. The data analysis team at ForestQuery has obtained data from the World Bank that includes forest area and total land area by country and year from 1990 to 2016, as well as a table of countries and the regions to which they belong.

The data analysis team has used SQL to bring these tables together and to query them in an effort to find areas of concern as well as areas that present an opportunity to learn from successes.

1. **GLOBAL SITUATION**

According to the World Bank, the total forest area of the world was 41,282,694.9 sq. km in 1990. As of 2016, the most recent year for which data was available, that number had fallen to 39,958,245.9 sq. km, a loss of 1,324,449 sq. km., or 3.21 %.

The forest area lost over this time period was slightly more than the entire land area of Peru listed for the year 2016 (which is 1,279,999.99 sq. km.).

2. **REGIONAL OUTLOOK**

In 2016, the percent of the total land area of the world designated as forest was 31.38%. The region with the highest relative forestation was Latin America & Caribbean, with 46.16%, and the region with the lowest relative forestation was Middle East & North Africa, with 2.07% forestation.

In 1990, the percent of the total land area of the world designated as forest was 32.42%. The region with the highest relative forestation was Latin America & Caribbean, with 51.03%, and the region with the lowest relative forestation was Middle East & North Africa, with 1.78% forestation.

Table 2.1: Percent Forest Area by Region, 1990 & 2016:

Region	1990 Forest Percentage	2016 Forest Percentage
Latin America & Caribbean	51.03	46.16
Europe & Central Asia	37.28	38.04
North America	35.65	36.04
Sub-Saharan Africa	30.67	28.79
East Asia & Pacific	25.78	26.36
South Asia	16.51	17.51
Middle East & North Africa	1.78	2.07

As you can see from this table, nations around the world have made an effort to recover some forested areas, even though the area recovered is small over the past two decades.
The only regions of the world that decreased in forested areas from 1990 to 2016 were Latin America & Caribbean region (dropped from 51.03% to 46.16%) and the Sub-Saharan African region (30.67% to 28.79%) which had both decreased by roughly 5 % and 2 % respectively. All other regions actually increased in forest area over this time period. However, the drop in forest area in the two aforementioned regions was so large, the percent forest area of the world decreased over this time period from 32.42% to 31.38%.

3. **COUNTRY-LEVEL DETAIL**

A. SUCCESS STORIES

There is one particularly bright spot in the data at the country level, China. This country actually increased in forest area from 1990 to 2016 by 527,229.06 sq. km. It would be interesting to study what has changed in this country over this time to drive this figure in the data higher. The country with the next largest increase in forest area from 1990 to 2016 was the United States of America (USA), but it only saw an increase of 79,200 sq. km., much lower than the figure for China.

China and the USA are of course very large countries in total land area, so when we look at the largest *percent* change in forest area from 1990 to 2016, we aren't surprised to find a much smaller country listed at the top. Iceland had doubled their forest area by just over 200 % (213.66 %) from 1990 to 2016.

B. LARGEST CONCERNS

Which countries are seeing deforestation to the largest degree? We can answer this question in two ways. First, we can look at the absolute square kilometer decrease in forest area from 1990 to 2016. The following 3 countries had the largest decrease in forest area over the time period under consideration: Brazil, Indonesia and Myanmar.

Table 3.1: Top 5 Amount Decrease in Forest Area by Country, 1990 & 2016:

Country	Region	Absolute Forest Area Change (sq. km.)
Brazil	Latin America & Caribbean	541,510.00
Indonesia	East Asia & Pacific	282193.98
Myanmar	East Asia & Pacific	107234.00
Nigeria	Sub-Saharan Africa	106506.00
Tanzania	Sub-Saharan Africa	102320.00

The second way to consider which countries are of concern is to analyze the data by percent decrease.

Table 3.2: Top 5 Percent Decrease in Forest Area by Country, 1990 & 2016:

Country	Region	Percent Forest Area Change
Togo	Sub-Saharan Africa	75.45
Nigeria	Sub-Saharan Africa	61.80
Uganda	Sub-Saharan Africa	59.13
Mauritania	Sub-Saharan Africa	46.75
Honduras	Latin America & Caribbean	45.03

When we consider countries that decreased in forest area percentage the most between 1990 and 2016, we find that four of the top 5 countries on the list are in the region of Sub-Saharan Africa. The countries are Togo, Nigeria, Uganda, and Mauritania. The 5th country on the list is Honduras, which is in the Latin America & Caribbean region.

From the above analysis, we see that Nigeria is the only country that ranks in the top 5 both in terms of absolute square kilometer decrease in forest as well as percent decrease in forest area from 1990 to 2016. Therefore, this country has a significant opportunity ahead to stop the decline and hopefully spearhead remedial efforts.

C. QUARTILES

Table 3.3: Distribution of countries grouped by forestation percent quartiles in 2016:

Percentiles	Number of Countries
Q1 (<25)	85
Q2 (25-50)	72
Q3 (50-75)	38
Q4 (>75)	22

The largest number of countries in 2016 were found in the first quartile.

There were only twenty two countries in the top quartile in 2016. These are countries with a very high percentage of their land area designated as forest. The following is a list of countries and their respective forest land, denoted as a percentage.

Table 3.4: Countries in the top quartile for the year 2016:

Country	Region	Pct Designated as Forest
Suriname	Latin America & Caribbean	98.26
Micronesia, Fed. Sts.	East Asia & Pacific	91.86
Gabon	Sub-Saharan Africa	90.04
Seychelles	Sub-Saharan Africa	88.41
Palau	East Asia & Pacific	87.61
American Samoa	East Asia & Pacific	87.5
Guyana	Latin America & Caribbean	83.9
Lao PDR	East Asia & Pacific	82.11
Solomon Islands	East Asia & Pacific	77.86

For some more context, the United States has 33.93% of forested land while being the world's largest economy in 2016[7]. Using that as a reference point, we found that there were just shy of 200 countries (197) that have more forested land than the USA had in 2016, which is very encouraging.

5. RECOMMENDATIONS

Based on our observations, the regions that were exhibiting sharp decreases in forested areas were in developing nations where these natural resources were being cleared for the benefit of the economy.[1] In regions such as Togo, forests were being cleared and used by the timber industry in the region that has led to the sharp decline in the forested areas in the region. The timber industry earmarked these regions for their purpose and was projected to bring in roughly $20 billion/ year.[2] Furthermore, part of the problem is that there are no restrictions/protections in place for these forested areas. [2] As we have learned in the past, harvesting natural resources that follow unsustainable practices can lead to vast destruction of flora and fauna, and for the industry itself, it is a short-sighted gain and will yield diminishing returns year-over-year.

This is the most common scenario in which we witness where deforestation levels are high -- these regions are economically poor, and no policies or protections are in place to ensure that certain forested regions remain untouched. Regions and countries with high forestation numbers as shown in table 3.4, are a result of restrictions mandated and enforced by their local government and a focus on a sustainable use of their natural resources. It is therefore important to dive deeper into understanding how nations in table 3.4 were able to preserve their forested land and apply what has been learned there to these nations.

However, there are some countries that still have the potential to implement changes that could greatly improve the global situation.We have gathered that the largest loss of forested area occurred in the Latin American & Carribean regions, there was about a 5% drop in forested area in these regions. The Amazonian rainforest in Brazil is undergoing deforestation at an alarming rate, from our data in table 3.1, we can see that the loss of forested area is above 550,000 sq. km. or 5.5 million hectares and will likely lose more than a quarter of their forested area by 2030 at this rate.[3] Heavily industrialized countries such as the ones presented in section 3.A were showing significant strides in reforestation of regions/states in their own country. For eg. China had returned roughly the same amount Brazil had destroyed, policies from their forestry industry can be emulated to help improve the situation in Brazil.

The next most important area would be the Sub-Saharan Africa region. As shown in table 3.1 and 3.2, out of the countries listed there, Nigeria is the country where we can still do some serious work to improve the situation there. There was a decrease of roughly 100,000 sq. km. or ~60% of their forested space and people in this country realize the importance of this natural resource.[4,5]

And lastly, it is important to look at the data gathered from major economies like China and the United States. Both these countries managed to establish themselves as the world's second largest and largest economies in 2016 while making massive strides in their reforestation efforts. Perhaps something can be learned from these countries and the way they manage their natural resources that could help developing nations in Sub-Saharan Africa as well as the Latin American & Carribean region in their efforts to protect and reforest their lands.

REFERENCES

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7. https://www.businessinsider.com/united-states-worlds-biggest-economy-2016-2

APPENDIX

```
-- Create a view named forestation that combines all 3 tables in dataset
CREATE VIEW forestation
AS
SELECT f.country_code, f.country_name, f.year, r.income_group, r.region,
f.forest_area_sqkm, COALESCE(land_tab.total_land_area,0.01) total_land_area,
ROUND((f.forest_area_sqkm*100/total_land_area)::numeric, 2) pct_forest_area
FROM (SELECT country_code, year, country_name, (total_area_sq_mi * 2.59)
total_land_area FROM land_area) land_tab
JOIN forest_area f
ON f.year = land_tab.year AND f.country_code = land_tab.country_code
JOIN regions r
ON land_tab.country_code = r.country_code;

-- Global Situation
-- History of forest area(1990):

SELECT forest_area_sqkm
FROM forestation
WHERE country_name = 'World'
AND year = '1990';
-- Assigning 2016 to year value in the WHERE clause will provide the value for 2016

-- Change (in sq km and percentage) in the forest area of the world from 1990 to 2016:
SELECT ( a.forest_area_sqkm-b.forest_area_sqkm ) AS loss_sqkm,
 ROUND((( a.forest_area_sqkm-b.forest_area_sqkm ) * 100 /
a.forest_area_sqkm)::numeric, 2)
 loss_percent
FROM forestation a,
 forestation b
WHERE a.year = 1990
 AND b.year = 2016
 AND a.country_name = 'World'
 AND b.country_name = 'World'
LIMIT 1;


-- compare the amount of forest area lost between 1990 and 2016, and to which
country's land mass is the area lost most similar to in 2016:
```

```
WITH ar_lost AS (SELECT b.year , ROUND(( a.forest_area_sqkm-b.forest_area_sqkm
)::numeric, 2) AS loss_sqkm
FROM forestation a,
 forestation b
WHERE a.year = 1990
 AND b.year = 2016
 AND a.country_name = 'World'
 AND b.country_name = 'World'
LIMIT 1)
SELECT f.country_name, f.total_land_area
FROM forestation f
JOIN ar_lost
ON f.year = ar_lost.year
WHERE f.total_land_area < ar_lost.loss_sqkm
ORDER BY 2 DESC
LIMIT 1;

-- REGIONAL OUTLOOK
-- What was the percent forest of the entire world in 2016?
SELECT ROUND(((total_forest/total_land)*100)::numeric, 2) pct_forest_world
FROM(SELECT f.year year_recorded,  SUM(forest_area_sqkm) total_forest,
SUM(total_land_area) total_land
FROM forestation f
WHERE f.year = 2016 AND f.country_name = 'World'
GROUP BY 1) sub
;

-- Which region had the HIGHEST percent forest in 2016, to 2 decimal places?
SELECT f.year year_recorded, f.region region_name,
ROUND(((SUM(f.forest_area_sqkm)/SUM(f.total_land_area))*100)::numeric, 2)
pct_forest
FROM forestation f
WHERE f.year = 2016
GROUP BY 1,2
ORDER BY 3 DESC
LIMIT 1;

-- and which had the LOWEST:
SELECT f.year year_recorded, f.region region_name,
ROUND(((SUM(f.forest_area_sqkm)/SUM(f.total_land_area))*100)::numeric, 2)
pct_forest
FROM forestation f
WHERE f.year = 2016
```

```
GROUP BY 1,2
ORDER BY 3
LIMIT 1;

-- What was the percent forest of the entire world in 1990?
SELECT ROUND(((total_forest/total_land)*100)::numeric, 2) pct_forest_world
FROM(SELECT f.year year_recorded,  SUM(forest_area_sqkm) total_forest,
SUM(total_land_area) total_land
FROM forestation f
WHERE f.year = 1990 AND f.country_name = 'World'
GROUP BY 1) fa_1990;


-- Which region had the HIGHEST percent forest in 1990, and which had the LOWEST,
to 2 decimal places?
SELECT f.year year_recorded, f.region region_name,
ROUND(((SUM(f.forest_area_sqkm)/SUM(f.total_land_area))*100)::numeric, 2)
pct_forest
FROM forestation f
WHERE f.year = 1990
GROUP BY 1,2
ORDER BY 3 DESC
LIMIT 1;

-- Based on the table you created, which regions of the world DECREASED in forest
area from 1990 to 2016

CREATE VIEW region_pct_diff
AS
-- using with subquery as aggregations are required prior to joining the tables in order to
retrieve a table with desired results
WITH fa_1990 AS
-- sum up forest area and land area and calculate percentage rounded to two digits
(SELECT f.region region_name,
ROUND(((SUM(f.forest_area_sqkm)/SUM(f.total_land_area))*100)::numeric, 2)
pct_forest
FROM forestation f
WHERE f.year = 1990
GROUP BY 1
ORDER BY 2 DESC
),
-- sums up forest area and land area and finds percentage of forest area in 2016
fa_2016 AS
```

```
(SELECT f.region region_name,
ROUND(((SUM(f.forest_area_sqkm)/SUM(f.total_land_area))*100)::numeric, 2)
pct_forest
FROM forestation f
WHERE f.year = 2016
GROUP BY 1
ORDER BY 2 DESC
)
-- joined the two temporary tables on region_name which will return regions and
pct_change for both years in separate columns
SELECT fa_2016.region_name, ROUND(fa_1990.pct_forest::numeric,2)
forest_pct_1990, ROUND(fa_2016.pct_forest::numeric,2) forest_pct_2016
-- using ::numeric casts the float8 value to numeric which can then be rounded down to
two digits.
FROM fa_1990
JOIN fa_2016
ON fa_2016.region_name = fa_1990.region_name
WHERE fa_2016.region_name NOT LIKE 'World';

-- to display view:
SELECT *
FROM region_pct_diff;

-- which regions of the world DECREASED in forest area from 1990 to 2016?

SELECT region_name regions, ROUND(forest_pct_1990::numeric, 2) 1990_forest_pct,
ROUND(forest_pct_2016::numeric, 2) 2016_forest_pct
FROM region_pct_diff
WHERE forest_pct_1990 - forest_pct_2016 > 0;

-- COUNTRY LEVEL DETAILS
-- Which 5 countries saw the largest amount decrease in forest area from 1990 to 2016?
-- What was the difference in forest area for each?

WITH c_fa_1990 AS
(SELECT country_name, forest_area_sqkm fa_1990
FROM forestation
WHERE year = 1990),
c_fa_2016 AS
(SELECT country_name countries, forest_area_sqkm fa_2016
FROM forestation
WHERE year = 2016)
```

```
SELECT country_name countries, ROUND((c_fa_1990.fa_1990 -
c_fa_2016.fa_2016)::numeric,2) AS fa_loss
FROM c_fa_1990
JOIN c_fa_2016
ON c_fa_2016.countries = c_fa_1990.country_name
WHERE c_fa_1990.fa_1990 - c_fa_2016.fa_2016 IS NOT NULL AND country_name
NOT LIKE 'World'
ORDER BY fa_loss DESC
LIMIT 5;

-- Which 5 countries saw the largest percent decrease in forest area from 1990 to 2016?
-- What was the percent change to 2 decimal places for each?
  WITH c_fa_1990 AS
  (SELECT country_name, forest_area_sqkm fa_1990
  FROM forestation
  WHERE year = 1990),
  c_fa_2016 AS
  (SELECT country_name countries, forest_area_sqkm fa_2016
  FROM forestation
  WHERE year = 2016)

  SELECT country_name countries, ROUND(((c_fa_1990.fa_1990 -
c_fa_2016.fa_2016)*100/c_fa_1990.fa_1990)::numeric,2) AS pct_fa_loss
  FROM c_fa_1990
  JOIN c_fa_2016
  ON c_fa_2016.countries = c_fa_1990.country_name
  WHERE c_fa_1990.fa_1990 - c_fa_2016.fa_2016 IS NOT NULL AND country_name
NOT LIKE 'World'
  ORDER BY fa_loss DESC
  LIMIT 5;

-- Number of countries grouped in their respective forested_area percentile range
-- Using CASE WHEN to include if-else logic allows us to filter on multiple clauses at the
same time

SELECT CASE WHEN pct_forest_area < 25 THEN 'Q1'
WHEN pct_forest_area BETWEEN 25 AND 50 THEN'Q2'
WHEN pct_forest_area BETWEEN 50 AND 75 THEN 'Q3'
ELSE 'Q4' END AS Percentiles,
COUNT(*) AS no_of_countries
FROM forestation
WHERE year = 2016 AND country_name NOT LIKE 'World'
GROUP BY 1;
```

-- How many countries had a percent forestation higher than the United States in 2016?

```
WITH usa_forest AS (SELECT year, pct_forest_area
FROM forestation
WHERE country_name LIKE '%United States%' AND year = 2016)
SELECT COUNT(*)
FROM forestation f
JOIN usa_forest uf
ON uf.year = f.year
WHERE f.forest_area_sqkm > uf.pct_forest_area  ;
```