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Project: Deforestation *For: Data Operations at Infosys*

Report for ForestQuery into Global Deforestation, 1990 to 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**

Great job all your answers in this section are correct, Kudos.

According to the World Bank, the total forest area of the world was 41,282,694.9 square kilometers (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 1,324,449.0 sq/km or a decrease of 3.20 %.

Yes, **Peru** is the country with the total land area closest to the amount of forest area lost between 1990 and 2016

The forest area lost over this time period is slightly more than the entire land area of Peru listed for the year 2016 (which is 1,279,999.9891 sq/km).

2. **REGIONAL OUTLOOK**

The regional outlook section contains the correct answers

In 2016, the percent of the total land area of the world designated as forest was 31.37. 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 2.06% 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 51.029%, and the region with the lowest relative forestation was Middle East & North Africa with 2.06% forestation.

Great job, the forest percentages for all the regions in this table is correct.

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

Region	1990 Forest Percentage	2016 Forest Percentage
East Asia & Pacific	25.77	26.35
Europe & Central Asia	37.28	38.04
Latin America & Caribbean	51.02	46.16
Middle East & North Africa	1.77	2.06
North America	35.65	36.03
South Asia	16.51	17.50
Sub-Saharan Africa	30.67	28.78
World	32.42	31.37

The only regions of the world that decreased in percent forest area from 1990 to 2016 were Latin America & Caribbean (dropped from 51.02 % to 46.16 %) and Sub-Saharan Africa 30.67% to 28.78 %). 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 31.37%.

3. **COUNTRY-LEVEL DETAIL**

Country-level detail sections contain the correct answers

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 33.55%. 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 but it only saw an increase of 2.62% much lower than the figure for China.

China and United States 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's forest area increased in forest area by 213.66% from 1990 to 2016.

Iceland is the country with the largest percent forest increase

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:

All the values in this table are correct, Kudos!

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

Country	Region	Absolute Forest Area Change
Brazil	Latin America & Caribbean	-54,1510.00
Indonesia	East Asia & Pacific	-282,193.98
Myanmar	East Asia & Pacific	-107,234.00
Nigeria	Sub-Saharan Africa	-106,506.00
Tanzania	Sub-Saharan Africa	-102,320.00

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

Correct, these are the top five countries with the highest forest percent decrease

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

Country	Region	Pct Forest Area Change
Togo	Sub-Saharan Africa	-75.44
Nigeria	Sub-Saharan Africa	-61.79
Uganda	Sub-Saharan Africa	-59.12

Mauritania	Sub-Saharan Africa	-46.74
Honduras	Latin America & Caribbean	-45.034

When we consider countries that decreased in forest area 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

The count of countries in the different quartiles is correct. I like that you excluded the **NULL** values from being counted.

Table 3.3: Count of Countries Grouped by Forestation Percent Quartiles, 2016:

Quartile	Number of Countries
Q1	85
Q2	73
Q3	38
Q4	9

The largest number of countries in 2016 were found in the 1st quartile.

There were 85 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.

The top quartile countries below are all correct, kudos!

Table 3.4: Top Quartile Countries, 2016:

Country	Region	Pct Designated as Forest
Suriname	Latin America & Caribbean	98.2576939676578
Micronesia, Fed. Sts	East Asia & Pacific	91.8572390715248
Gabon	Sub-Saharan Africa	90.0376418700565
Seychelles	Sub-Saharan Africa	88.4111367385789
Palau	East Asia & Pacific	87.6068085491204
American Samoa	East Asia & Pacific	87.5000875000875
Guyana	Latin America & Caribbean	83.9014489110682
Lao PDR	East Asia & Pacific	82.1082317640861
Solomon Islands	East Asia & Pacific	77.8635177945066

4. RECOMMENDATIONS

We also need to focus on deforestation countries based on the income region .

There are 4 distinct income levels according to the World Data.

Great job, with your recommendations. The recommendations are very elaborate and you made some very good points.

Table 4.1: Distinct Types of Income Group

Income Group
High income
Low income
Lower middle income
Upper middle income

As you can see in the table below, majority of the countries with largest percent forest areas fall into either High Income group or Upper Middle Income categories for 2016. There were 80 countries found in the high income group and the last on the list is Low Income group which is comprised of only 34 countries.

Table 4.2: Count of countries by Income Group, 2016

Income Group	# Countries	Forest Area (%)
High income	80	2.33326844754312
Upper middle income	56	28.1218985468193
Lower middle income	47	46.3072105414897
Low income	34	2.06782463263315

It would be interesting to study if the deforestation rises with income in developing countries. The effect of financial crises based on the forest loss would be interesting to investigate as well. Unfortunately, due to the limitation of our datasets, I am unable to provide the measurements.

5. APPENDIX: SQL queries used

```
-- Create a view by joining all 3 tables with a new column
CREATE VIEW forestation AS
SELECT
 fo.country_code,
 fo.country_name,
 fo.YEAR,
 fo.forest_area_sqkm,
 la.total_area_sq_mi,
 re.region,
 re.income_group,
 (
  fo.forest_area_sqkm / (la.total_area_sq_mi * 2.59) --Convert 1sqmi=2.59sqkm)
 )
 * 100 AS forest_percentage
FROM
 FOREST_AREA AS fo
 JOIN
  LAND_AREA AS la
  ON fo.country_code = la.country_code
  AND fo.YEAR = la.YEAR
 JOIN
  REGIONS AS re
  ON la.country_code = re.country_code
```

This creates a View successfully.

```sql
-- Total forest area of the world in 1990
SELECT
  forest_area_sqkm
FROM
  forestation
WHERE
  country_name = 'World'
  AND year = 1990
```

Output 1 results

forest_area_sqkm
41282694.9

```sql
-- Total forest area of the world in 2016
SELECT
  forest_area_sqkm
FROM
  forestation
WHERE
  country_name = 'World'
  AND year = 2016
```

Output 1 results

forest_area_sqkm
39958245.9

```sql
-- Change in the forest area of the world from 1990-2016
SELECT
  t2.forest_area_sqkm - t1.forest_area_sqkm as loss_area
FROM
  forestation AS t2,
  forestation AS t1
WHERE
  t2.year = 2016
  AND t2.country_name = 'World'
  AND t1.year = 1990
  AND t1.country_name = 'World'
```

Output 1 results

loss_area
-1324449

```sql
-- Percent change in forest area of the world from 1990-2016
SELECT
  (t2.forest_area_sqkm - t1.forest_area_sqkm) / t1.forest_area_sqkm * 100 as percentage_loss
FROM
  forestation     AS t2
  JOIN
    forestation AS t1
      ON (
          t2.year = 2016
          AND t2.country_name = 'World'
          AND t1.year = 1990
          AND t1.country_name = 'World'
        )
```

Output 1 results

percentage_loss
-3.20824258980244

```sql
-- Compare forest area loss b/w 1990-2016 to country's total area in 2016 (top 1)
SELECT
  fo.country_name,
  la.total_area_sq_mi * 2.59 AS total_area_sqkm
FROM
  FOREST_AREA   AS fo
  JOIN
    LAND_AREA as la
      ON fo.country_code = la.country_code
       AND fo.year = la.year
WHERE
  la.total_area_sq_mi <= 1324449.0
  AND fo.year = 2016
ORDER BY
  total_area_sqkm desc
LIMIT 1
```

Output 1 results

country_name	total_area_sqkm
Peru	1279999.9891

```
--Shows the regions and their forest area (in percentage) in 1990 and 2016
SELECT
 region,
 (
  SUM (forest_area_sqkm) / SUM (total_area_sq_mi * 2.59) * 100
 ) AS forest_percent,
 year
FROM
 forestation
WHERE
 year IN ('1990', '2016')
GROUP BY region, year
ORDER BY region, year
```

Output 16 results Download CSV

region	forest_percent	year
East Asia & Pacific	25.7760953973175	1990
East Asia & Pacific	26.3586765000485	2016
Europe & Central Asia	37.2839398564019	1990
Europe & Central Asia	38.0414216032517	2016
Latin America & Caribbean	51.0299798667514	1990
Latin America & Caribbean	46.1620721996047	2016
Middle East & North Africa	1.77524062469353	1990
Middle East & North Africa	2.06826486871501	2016
North America	35.6511790009015	1990
North America	36.0393609681438	2016
South Asia	16.510767001421	1990
South Asia	17.5058634081534	2016
Sub-Saharan Africa	30.6741454610006	1990
Sub-Saharan Africa	28.7881883550464	2016
World	32.4222035575689	1990
World	31.3755709643095	2016

```
--Countries with largest increase of forest area (Success stories)
SELECT
 t2.country_name AS country,
 100.0*(t2.forest_area_sqkm - t1.forest_area_sqkm) / t1.forest_area_sqkm AS percent_decrease
FROM forest_area AS t2
 JOIN forest_area AS t1
  ON t2.YEAR = '2016'
  AND t1.YEAR = '1990' AND t2.country_name = t1.country_name
WHERE 100.0*(t2.forest_area_sqkm - t1.forest_area_sqkm) / t1.forest_area_sqkm IS NOT NULL
ORDER BY percent_decrease desc
limit 1
```

Output 1 results

country	percent_decrease
Iceland	213.664588870028

```
SELECT
 t2.country_name AS country,
 t1.region,
 ROUND(CAST(((t2.forest_area_sqkm - t1.forest_area_sqkm)) AS NUMERIC),2
 ) AS loss_forest
FROM forestation AS t2
 JOIN forestation AS t1
  ON (t2.year = '2016'AND t1.year = '1990')
  AND t2.country_code = t1.country_code
WHERE t2.country_name != 'World' AND t2.forest_area_sqkm != 0 AND t1.forest_area_sqkm != 0
ORDER BY loss_forest DESC
LIMIT 2;
```

Output 2 results

country	region
China	East Asia & Pacific
United States	North America

```
--Top 5 countries w/ largest amount decrease from 1990-2016
SELECT
 t2.country_name AS country,
 ROUND(CAST(((t2.forest_area_sqkm - t1.forest_area_sqkm)) AS NUMERIC), 2) AS loss_forest
FROM
 forestation AS t2
 JOIN
  forestation AS t1
  ON t2.YEAR = 2016
  AND t1.YEAR = 1990
  AND t2.country_code = t1.country_code
WHERE
 t2.country_name != 'World'
 AND t2.forest_area_sqkm != 0
 AND t1.forest_area_sqkm != 0
ORDER BY loss_forest ASC
LIMIT 5;
```

Output 5 results

country	loss_forest
Brazil	-541510.00
Indonesia	-282193.98
Myanmar	-107234.00
Nigeria	-106506.00
Tanzania	-102320.00

```
--Top 5 countries w/ largest percent (%) decrease from 1990-2016
SELECT
 t2.country_name AS country,
 100.0*(t2.forest_area_sqkm - t1.forest_area_sqkm) / t1.forest_area_sqkm AS percent_decrease
FROM
 forest_area AS t2
 JOIN
  forest_area AS t1
  ON t2.YEAR = '2016'
  AND t1.YEAR = '1990'
  AND t2.country_name = t1.country_name
WHERE
 100.0*(t2.forest_area_sqkm - t1.forest_area_sqkm) / t1.forest_area_sqkm IS NOT NULL
ORDER BY
 percent_decrease ASC
LIMIT 5
```

Output 5 results

country	percent_decrease
Togo	-75.4452559270073
Nigeria	-61.7999309388418
Uganda	-59.1286034729531
Mauritania	-46.7469879518072
Honduras	-45.0344149459194

```
--Retrieve which group had the most countries in 2016 (grouped in quartiles)
SELECT
 DISTINCT(quartiles),
 COUNT(country_name) OVER (PARTITION BY quartiles)
FROM
 (
  SELECT
   country_name,
   CASE
    WHEN forest_percentage <= 25 THEN '0-25%'
    WHEN forest_percentage <= 75
    AND forest_percentage > 50 THEN '50-75%'
    WHEN forest_percentage <= 50
    AND forest_percentage > 25 THEN '25-50%'
    ELSE '75-100%'
   END AS quartiles
  FROM
   forestation
  WHERE
   forest_percentage IS NOT NULL
   AND year = 2016
 ) quart
```

Output 4 results

quartiles	count
0-25%	85
25-50%	73
50-75%	38
75-100%	9

```
--All countries in the 4th quartile (percent forest > 75%) in 2016
SELECT
 region,
 country_name,
 forest_percentage
FROM
 forestation
WHERE
 forest_percentage > 75
 AND YEAR = 2016
ORDER BY
 forest_percentage DESC
```

Output 9 results Download CSV

country_name	region	forest_percentage
Suriname	Latin America & Caribbean	98.2576939676578
Micronesia, Fed. Sts.	East Asia & Pacific	91.8572390715248
Gabon	Sub-Saharan Africa	90.0376418700565
Seychelles	Sub-Saharan Africa	88.4111367385789
Palau	East Asia & Pacific	87.6068085491204
American Samoa	East Asia & Pacific	87.5000875000875
Guyana	Latin America & Caribbean	83.9014489110682
Lao PDR	East Asia & Pacific	82.1082317640861
Solomon Islands	East Asia & Pacific	77.8635177945066

```
--Count countries w/ higher percentage (%) forestation than US in 2016
SELECT
 COUNT (*)
FROM
 forestation
WHERE
 forest_percentage > (
  SELECT
   forest_percentage
  FROM
   forestation
  WHERE
   country_name = 'United States'
   AND YEAR = '2016'
 )
 AND YEAR = '2016'
```

Output 1 results

count
94