GIS Final Paper: Trends in Sustainability

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URP4273: Planning Information Systems

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Intro/Main Goal:

As the world continues to grow and develop the more people will start to look at how these changes affect the environment around them. In response to the Intergovernmental Panel on Climate Change (IPPCC) monthly report, Kevin Anderson stated that he thought that the majority of the worlds emission come from the minority of the world. This project will walk through different measures and indexes, such as health, social, and education that are meant to analyze the countries of the world and determine how they compare to each other. Our hypothesis is that more developed countries will be less sustainable. This means that, when using our scale, a higher score for quality of life, education and communication, and world development should correspond to a lower sustainability index score.

Background:

The world is undergoing major changes. More countries are now considered developed or developing than have ever been before. Along with this, global climate change is reaching a point of no return. If the governments and countries of the world do not act now, the effects of

climate change will soon be irreversible. It is difficult to address the issue as a worldwide problem. To say “every country needs to tackle the issue of climate change” does not give any answers. One important aspect of environmentalism and sustainability is that it is local. The solutions to the different causes of climate change depend on where the focus area is. The methods used to mitigate heat island effect in New York City are different than the water conservation strategies taking place in South Africa. That being said, there are countries that are responsible for the majority of climate change effects. Only 20% of the world’s nations are responsible for 50% of global emissions.

To address this inequality issue, it would be useful to map out where these hotspots are on Earth. To do this, we will be assessing the environmental impact of all of the countries in the world in relation to the stage of development that the country is in. Since the data is varied and development can be subjective, we redefined environmental impact as a “sustainability index” and development as a “progress index”. Our hypothesis is that countries that are higher on the progress index will have a lower sustainability index.

Scope and Characteristics of Analysis:

Since climate change is considered to be global, the subject area will be the entire world. This offers some opportunities but also creates some limitations. The opportunities are that having a large subject area allows for us to obtain varied and unbiased data. The majority of the data will come from reputable world organizations such as The United Nations, The World Bank, and The World Health Organization. This data has also been generalized, or normalized. Everything will be easily comparable, which is necessary for this project. Some of the limitations are that there is inconsistency in the data. Some of the data sources date back to the 1970s, while others have large amounts of data from very recent years. In order to adapt to this, we had to expand our scope back to 2000. This can alter the results, as a country's data from 2015 may not necessarily be comparable to another country's data from 2005. The data is also inconsistent across different formats. For example, The United States has recent data for a lot of our indicators, but it does not have data for Male and Female Literacy Rates. This caused the data to be skewed for their education total. Other countries may have ended up higher or lower on our final index than they should have been because of this. We also had to omit some countries from the final tally entirely, as the 0 to represent no data would have skewed the totals. Another drawback to having such a large subject area is that we had to make a lot of assumptions about the data. The metadata was not always available, so we had to assume that every country measure every indicator the same way. With the time period, we had to assume that older data was comparable to older data.

Objectives:

The objective of this project is to determine if the statement "50% of global carbon emissions arise from the activities of around 10% of the global population, increasing to 70% of emissions from just 20% of citizens" is true or false when compared to the data that we were able to find and compile.

We will achieve our objective of analyzing the environmental impacts of the world through index measures in different areas. The four measure areas that will be focused on are quality of life, education and communication, world development, and a sustainability index. The Quality of life section shows impacts on society as well as life expectancy and the overall quality of life. Education and communication shows literacy rates and highlights the access to education. World development gives a broad overview of what governments value as well as insight to how developed a country is. The sustainability index connects all other measures to show how a country functions as well as the impacts it has on the environment around them.

Once all the data is found we will analyze the data and create a database that gives values to all of the measures. A total will be found for each country and added together to create a progress index. The highest total score, 220, will indicate a highly developed country. This will then be compared to the total number found for the sustainability index and a higher score, 40, will indicate a highly sustainable country. It is important to keep in mind that the data sets that were used did not always have data for every country. This caused some outlying points due to the fact that data could not be obtained for every category for certain countries. We are taking this into consideration when reviewing and analyzing the data.

Methodology:

The first step to reaching the objectives, was to form a complete list of measure and indexes we wanted to use to determine how developed and how sustainable a country is. We determined that we would use four different measures: world development, education and communication, quality of life, and sustainability. Of these four measure the first three were combined to create the progress index, and the final measure, sustainability, became its own index, called the sustainability index. Once we had our final two indices, we created a graph which showed the correlation between the sustainability and progress indices. A trendline was added and the graph was used to support our hypothesis that more progressive countries have a lower sustainability measure. The process is outlined in figure 1.

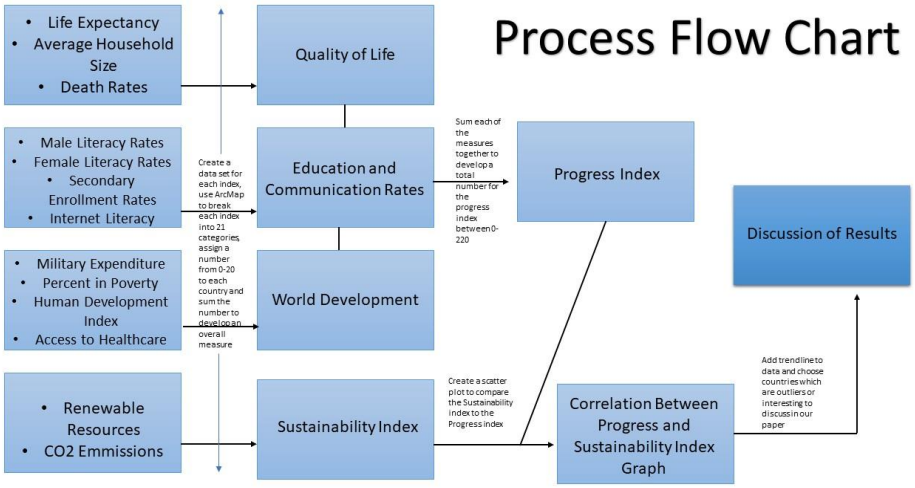

Figure 1: Process flow chart, describing the steps

In the world development measure we had four different indices: access to healthcare, the percent of the population that lives below the poverty line, the human development index, and the percent of the gross domestic product spent on the military. Out of these four indices, three were given, and we collected and compiled data to create the access to healthcare index. The data

for this index came from the “Economist Intelligence Unit”, who defines access to healthcare as “access to child and maternal health services; access to infectious diseases care; access to non-communicable diseases care; access to medicines; and equity of access to healthcare.” The rankings that they determined were added to a map of the world in ArcMap and was then used to to break the rankings into 21 categories. As is the case for all the indices, we chose 21, so that a country with no data could be entered as a zero. ArcMap was used to select data by attributes and each country was assigned a number from zero to twenty, twenty being the best. This process was repeated for each index, and a table was created in excel to track each country’s ranking. Once all of the measures had been tracked, each index was added together to create a composite score for the total measure (in this case the highest score could be 80). This score was put into ArcMap and broken into 7 categories to see the geospatial distribution of the measure.

Similar to the world development measure, the education and communication measure used four measures; these are: male and female literacy rates, enrollment in secondary school, and internet literacy rates (or access to internet). Of these four indices, only data for enrollment rates in secondary schools was found and not given. This data set came from the World Bank, and was defined as the percentage of school-aged children enrolled in a secondary school. The process analysis for each of the indices is the same process outlined above, this measure could also score as high as 80 (to see the individual measure maps, refer to appendix 1-3).

The last measure which was combined to compare to the sustainability index, was the quality of life measure. This measure had three indices: life expectancy, average household size, and death rates. The average household size was included under the assumption that smaller household sizes would be more common in more progressive countries, and indicate a higher quality of life; for this reason, the smallest households were given a 20, and the largest

households were assigned a 1. This data set was found at population.un.org. As well as the average household size, we also found data for the death rates; this data set was meant to show that less developed countries would have higher death rates, because of less access to healthcare, or because of war or other factors. The death rates data came from the world bank, who defined death rate as "the average number of deaths per 1000 people". As done with the other two measures, the data was input into ArcMap, where it was assigned a number from zero to twenty. Once the composite score was found, the highest score in this measures could be sixty.

Once of all three of these measure were defined, placed in ArcMap, and assigned a number from zero to twenty, we transposed the data sets into Microsoft excel, and the overall number for each data set was added together to create a progress index. This index could have a score as high as 220, but the highest scoring country only reached 176.

We used the same method described above to create a sustainability index. This index included CO2 emissions for each country, and the percentage of renewable resources used to power each country. As with death rates and average household size, for CO2 emission we took a higher number to be bad, so the lowest emissions received a score of 20, and the highest emissions received a score of one. This index could have a score as high as fourty.

Once we had both the sustainability and progress indices created, we used excel to create a scatter plot, excluding any countries which had zero (no data) inputs and fit the data with a trendline. The results are discussed below.

Results and Discussion:

We found our hypothesis to be correct. The trendline fit across the graph (see figure 2) showed a negative slope, implying that there is an inverse relationship between a country's progress and their ability to be sustainable. This is a relatively weak correlation, and we have

chosen a few countries to talk about that stood out as interesting to us. It is also important to note, that because we decided that any index without data would be input as a zero, some countries which expected to score higher on the progress or sustainability index did not score as well as would have been expected. For example, Iceland and many other Scandinavian countries which we expected to score high in both the sustainability and progress indices, scored lower than we would have assumed, because many index fields were filled in as a zero.

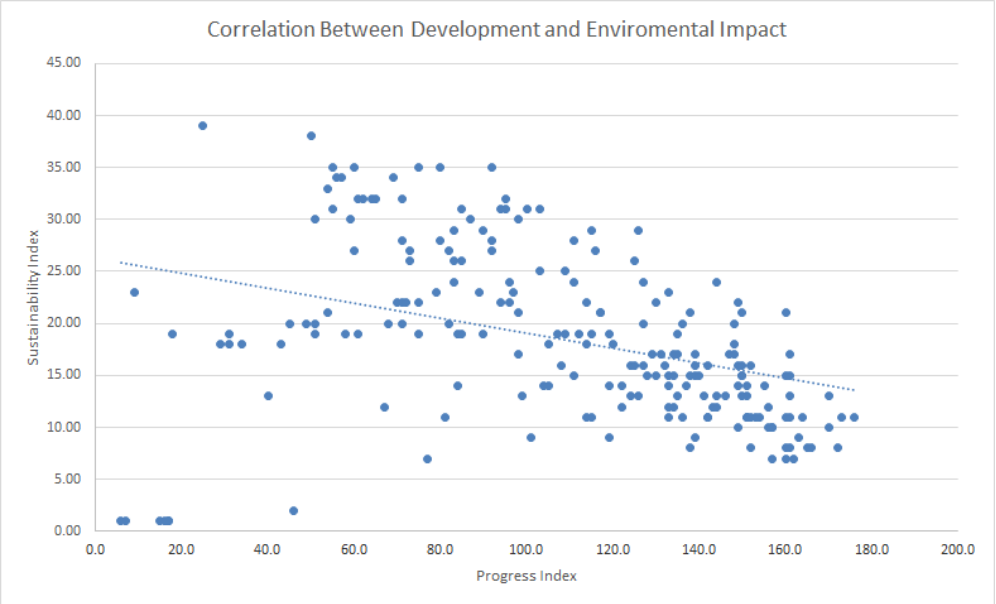

Figure 2: “Correlation between Progress and

The first of interesting country is Slovenia, which scored the highest on the progress index, with a score of 176. This score is largely because they scored 74 out of a total of 80 in the education and communication measure. This score combined with Slovenia’s quality of life and world development scores out performed all of the other countries. Slovenia's education score was near perfect, because they have high rates of literacy and an excellent public education system in place. However, they only have a score of 11 out of 40 on our sustainability index. This is because a large number of their gas and oil imports.

A country which has a similar situation, is Bahrain. Bahrain is a highly progressive country, which had the lowest sustainability score, a seven. Despite having a progress score of

160, they only scored a 7 on our sustainability index, this may be because they are an oil rich country and depend heavily on oil and other fossil fuels to power their highly modernized cities. Somalia scored the highest out of all 246 on our sustainability index. It had a score of 39, which we believe is likely not due to progressive emerge practices, but more likely due to a lack of energy. As is similar for most of Africa, Somalia does not use much electricity, because it is a still developing country it does not have much infrastructure in place to get electricity to its citizens.

In general, Africa tended to be more sustainable than the rest of the world(see figure 3). This is likely for the same reasons as Somalia, there is a lack of electricity in these countries, but because they are still developing there is a good chance that the infrastructure they put in place will be more sustainability from the get-go, than the infrastructure progressive countries are using now. When looking at both the Sustainability Index map and the Progress Index map (see figure 4), it is clear that as a general pattern, if a country is dark on one map (meaning that it has a high score for that index), it is lighter on the other map (meaning that it has a low score on the other index). This is a way to visually display the data in support of our hypothesis.

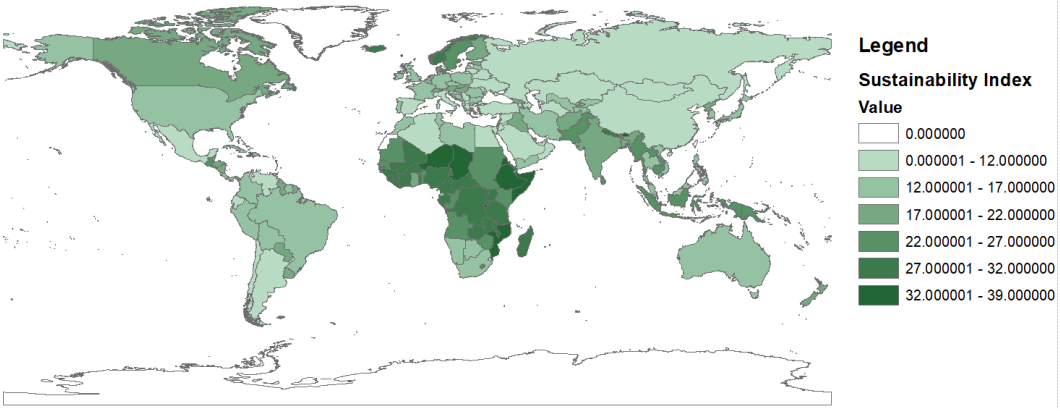

Figure 3: Sustainability Index map of the entire world.

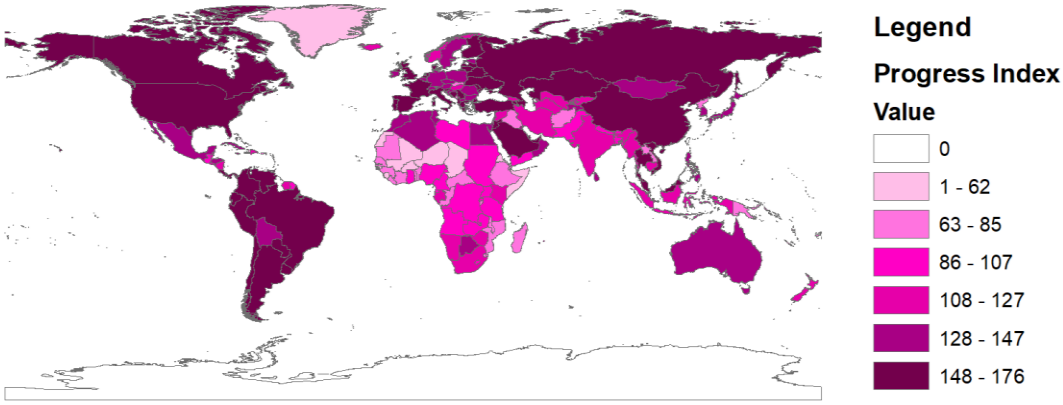

Figure 4: Progress Index map of the entire world. A darker shade of pink indicates a higher score on the progress

Conclusion:

After compiling all of our data and creating an index we were able to prove our hypothesis correct. In the scatterplot it can be seen that the trendline declines the more developed

a country is. This means that as a country becomes more developed they decrease in sustainability. As countries begin to grow it is important, as the data shows, they they are aware they will need to be more conscious of how that will affect the world around them.

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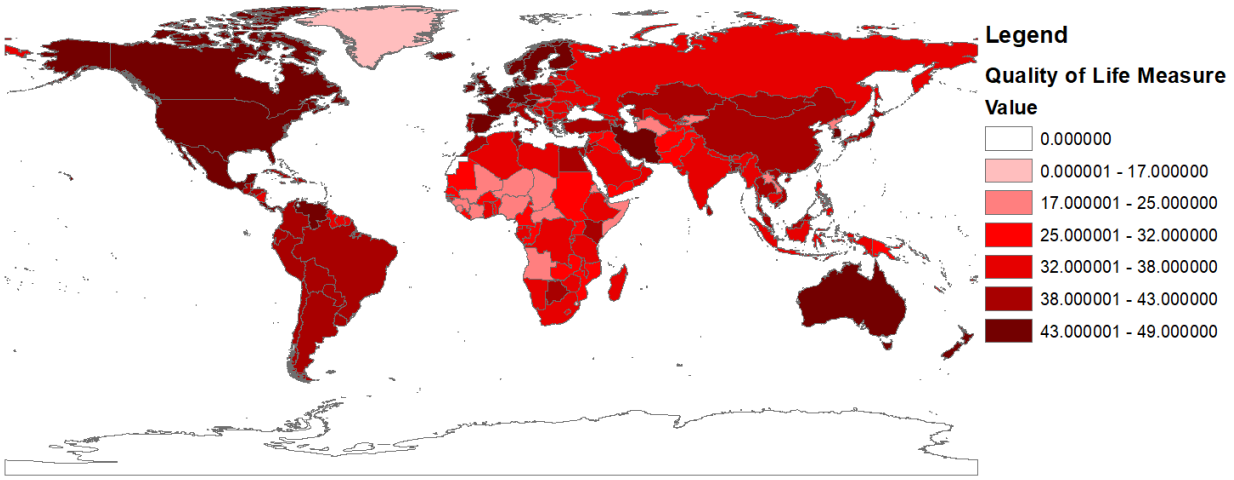
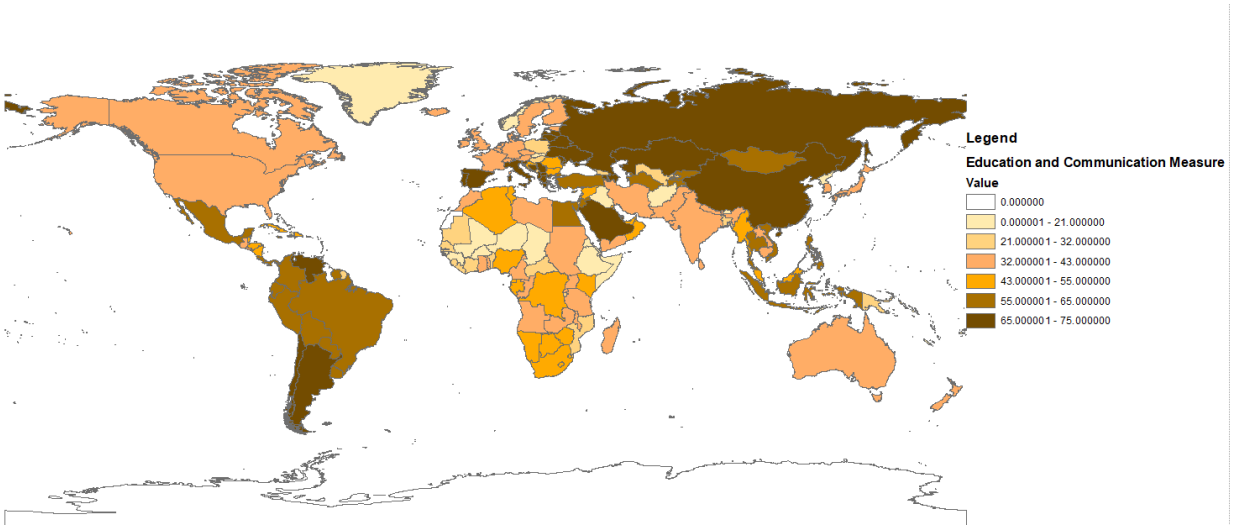
Appendix:

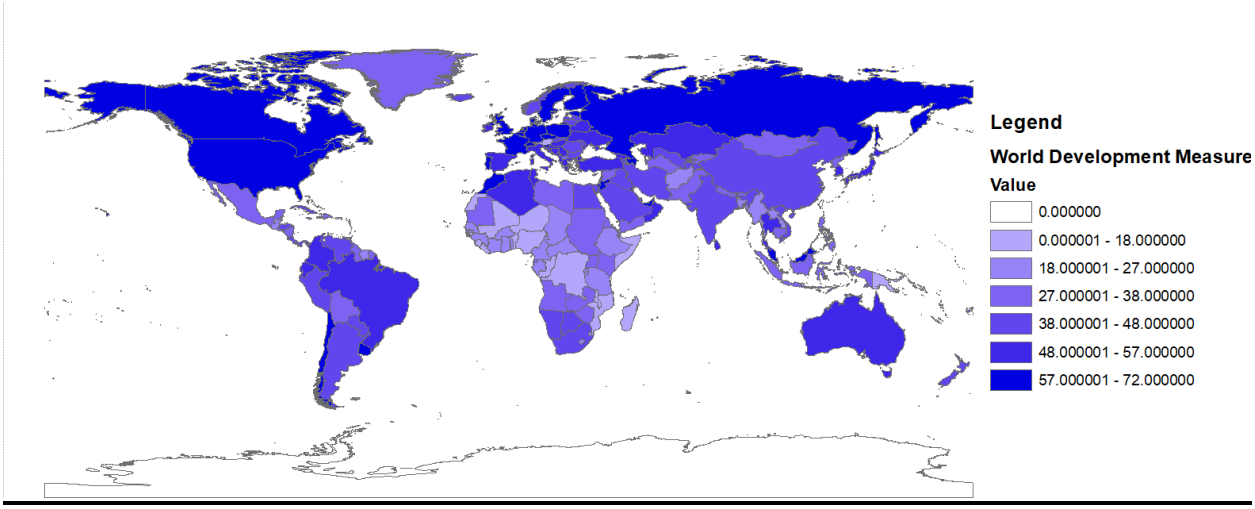
Appendix 1



Appendix 2



Appendix 3


Legend
World Development Measure
Value
0.000000
0.000001 - 18.000000
18.000001 - 27.000000
27.000001 - 38.000000
38.000001 - 48.000000
48.000001 - 57.000000
57.000001 - 72.000000

Appendix 4

Country	Quaili	Education ar	World Development	Total	Enviroment Impact
Afghanistan	27	21	23	71.0	20.00
Aland Islands	0	0	0	0.0	0.00
Albania	40	69	52	161.0	15.00
Algeria	34	49	51	134.0	12.00
American Samoa	6	0	0	6.0	1.00
Andorra	15	19	20	54.0	21.00
Angola	22	36	31	89.0	23.00
Anguilla	17	0	0	17.0	0.00
Antarctica	0	0	0	0.0	0.00
Antigua & Barbuda	46	13	31	90.0	19.00
Argentina	42	69	46	157.0	10.00
Armenia	37	69	48	154.0	11.00
Aruba	41	56	17	114.0	11.00
Australia	48	36	49	133.0	15.00
Austria	45	33	60	138.0	21.00
Azerbaijan	39	70	63	172.0	8.00
Bahamas, The	42	15	52	109.0	19.00
Bahrain	38	71	51	160.0	7.00
Bangladesh	39	32	27	98.0	21.00
Barbados	38	25	35	98.0	17.00
Belarus	38	71	56	165.0	8.00
Belgium	45	36	58	139.0	15.00
Belize	40	49	23	112.0	19.00
Benin	30	25	18	73.0	27.00
Bermuda	47	20	38	105.0	18.00
Bhutan	38	18	36	92.0	35.00
Bolivia	40	60	35	135.0	13.00
Bosnia & Herzegovina	39	72	49	160.0	15.00
Botswana	39	47	43	129.0	17.00
Bouvet Island	0	0	0	0.0	0.00
Brazil	43	63	55	161.0	17.00
British Indian Ocean Territory	0	0	0	0.0	0.00
British Virgin Is.	0	0	0	0.0	1.00
Brunei Darussalam	33	52	48	133.0	11.00
Bulgaria	36	51	46	133.0	14.00
Burkina Faso	27	16	19	62.0	32.00
Burundi	27	30	23	80.0	35.00
Cambodia	37	42	30	109.0	25.00
Cameroon	27	41	24	92.0	28.00
Canada	48	36	64	148.0	18.00
Cape Verde	0	42	30	72.0	0.00
Cayman Islands	0	15	16	31.0	19.00

Central African Rep.	21	24	19	64.0	32.00
Chad	19	17	19	55.0	35.00
Chile	43	71	59	173.0	11.00
China	43	66	47	156.0	10.00
Christmas Island	0	0	0	0.0	0.00
Cocos (Keeling) Islands	0	0	0	0.0	0.00
Colombia	42	65	54	161.0	13.00
Comoros	30	13	13	56.0	34.00
Congo, Dem. Rep.	26	39	18	83.0	26.00
Congo, Repub. of the	36	50	9	95.0	31.00
Cook Islands	0	0	0	0.0	0.00
Costa Rica	45	64	40	149.0	16.00
Cote d'Ivoire	21	28	22	71.0	28.00
Croatia	38	54	55	147.0	17.00
Cuba	42	46	40	128.0	15.00
Cyprus	46	54	43	143.0	12.00
Czech Republic	43	34	58	135.0	17.00
Denmark	46	37	65	148.0	20.00
Djibouti	22	11	37	70.0	22.00
Dominica	17	12	22	51.0	20.00
Dominican Republic	42	51	29	122.0	14.00
Ecuador	43	63	54	160.0	11.00
Egypt	40	56	46	142.0	11.00
El Salvador	40	38	36	114.0	18.00
Equatorial Guinea	29	45	31	105.0	14.00
Eritrea	25	6	29	60.0	35.00
Estonia	41	35	60	136.0	20.00
Ethiopia	35	21	19	75.0	35.00
Falkland Islands (Malvinas)	0	0	0	0.0	0.00
Faroe Islands	45	19	51	115.0	19.00
Fiji	35	8	42	85.0	26.00
Finland	45	39	65	149.0	22.00
France	46	35	67	148.0	17.00
French Polynesia	30	12	26	68.0	20.00
French Southern and Antarctic Lands	0	0	0	0.0	0.00
Gabon	36	48	27	111.0	28.00
Gambia, The	24	10	17	51.0	30.00
Georgia	33	27	57	117.0	21.00
Germany	44	35	60	139.0	17.00
Ghana	37	36	21	94.0	22.00
Gibraltar	17	0	0	17.0	1.00
Greece	42	68	51	161.0	11.00
Greenland	9	14	29	52.0	0.00
Grenada	27	8	40	75.0	22.00
Guadeloupe	0	0	0	0.0	0.00
Guam	44	14	26	84.0	19.00
Guatemala	39	33	20	92.0	27.00

Guernsey	0	0	0	0.0	0.00
Guinea	23	21	21	65.0	32.00
Guinea-Bissau	27	5	18	50.0	38.00
Guyana	37	25	34	96.0	22.00
Haiti	33	11	13	57.0	34.00
Heard Islands and McDonald Islands	0	0	0	0.0	0.00
Holy See (Vatican City)	0	0	0	0.0	0.00
Honduras	43	48	39	130.0	22.00
Hong Kong	46	15	0	61.0	19.00
Hungary	37	32	51	120.0	18.00
Iceland	47	38	41	126.0	29.00
India	35	40	42	117.0	21.00
Indonesia	38	56	33	127.0	24.00
Iran	44	41	41	126.0	13.00
Iraq	31	12	42	85.0	19.00
Ireland	47	35	57	139.0	16.00
Isle of Man	0	0	0	0.0	1.00
Israel	48	29	65	142.0	16.00
Italy	43	69	52	164.0	11.00
Jamaica	43	60	38	141.0	13.00
Japan	43	38	57	138.0	15.00
Jersey	0	0	0	0.0	0.00
Jordan	41	63	59	163.0	9.00
Kazakhstan	40	68	53	161.0	8.00
Kenya	39	48	38	125.0	26.00
Kiribati	29	15	7	51.0	19.00
Korea, Dem. People's Rep. of	21	20	30	71.0	22.00
Korea, Rep. of	49	36	52	137.0	14.00
Kuwait	38	54	50	142.0	11.00
Kyrgyzstan	25	64	35	124.0	13.00
Lao People's Dem. Rep.	19	42	22	83.0	24.00
Latvia	35	75	45	155.0	14.00
Lebanon	42	32	56	130.0	15.00
Lesotho	30	45	22	97.0	23.00
Liberia	32	29	10	71.0	32.00
Libya	35	38	31	104.0	14.00
Liechtenstein	48	19	20	87.0	30.00
Lithuania	36	73	47	156.0	12.00
Luxembourg	47	35	42	124.0	16.00
Macau	15	52	0	67.0	12.00
Macedonia	37	70	37	144.0	12.00
Madagascar	36	37	7	80.0	28.00
Malawi	35	35	15	85.0	31.00
Malaysia	40	50	60	150.0	13.00
Maldives	41	63	35	139.0	9.00
Mali	25	18	16	59.0	30.00
Malta	45	50	51	146.0	13.00

Marshall Islands	3	3	3	9.0	23.00
Martinique	0	0	0	0.0	0.00
Mauritania	27	23	29	79.0	23.00
Mauritius	26	43	42	111.0	15.00
Mayotte	12	0	0	12.0	0.00
Mexico	44	59	33	136.0	11.00
Micronesia, Fed. St.	31	6	12	49.0	20.00
Moldova	37	68	44	149.0	10.00
Monaco	30	0	0	30.0	0.00
Mongolia	43	63	32	138.0	8.00
Montengero	0	31	53	84.0	14.00
Montserrat	20	0	0	20.0	0.00
Morocco	40	42	58	140.0	15.00
Mozambique	30	24	15	69.0	34.00
Myanmar	36	50	25	111.0	24.00
Namibia	35	51	41	127.0	16.00
Nauru	4	14	0	18.0	19.00
Nepal	38	36	29	103.0	31.00
Netherlands	46	38	66	150.0	15.00
Netherlands Antilles	0	40	0	40.0	13.00
New Caledonia	30	14	14	58.0	19.00
New Zealand	47	37	43	127.0	20.00
Nicaragua	38	45	31	114.0	22.00
Niger	23	18	13	54.0	33.00
Nigeria	25	48	17	90.0	29.00
Niue	16	0	0	16.0	0.00
Norfolk Island	0	0	0	0.0	0.00
N. Mariana Islands	15	0	0	15.0	1.00
Norway	47	20	48	115.0	29.00
Oman	36	47	50	133.0	12.00
Pakistan	28	33	35	96.0	24.00
Palau	7	0	0	7.0	1.00
Palestinian Authority	0	67	10	77.0	7.00
Panama	44	64	43	151.0	13.00
Papua New Guinea	32	26	15	73.0	26.00
Paraguay	39	63	48	150.0	21.00
Peru	42	61	46	149.0	14.00
Philippines	37	59	38	134.0	15.00
Pitcairn Islands	0	0	0	0.0	0.00
Poland	41	32	58	131.0	17.00
Portugal	42	70	58	170.0	13.00
Puerto Rico	44	15	16	75.0	19.00
Qatar	37	73	47	157.0	7.00
Reunion	0	0	0	0.0	0.00
Romania	36	50	46	132.0	16.00
Russia	36	70	60	166.0	8.00
Rwanda	38	34	23	95.0	32.00

Saint Barthelemy	0	0	0	0.0	0.00
Saint Helena	0	0	0	0.0	0.00
Saint Kitts & Nevis	0	17	17	34.0	18.00
Saint Lucia	17	19	7	43.0	18.00
Saint Martin	17	0	0	17.0	1.00
St Pierre & Miquelon	0	0	0	0.0	0.00
Saint Vincent and the Grenadines	32	0	14	46.0	2.00
Samoa	30	56	15	101.0	9.00
San Marino	10	11	10	31.0	18.00
Sao Tome & Principe	38	53	16	107.0	19.00
Saudi Arabia	38	67	47	152.0	8.00
Senegal	28	30	24	82.0	27.00
Serbia	33	69	49	151.0	11.00
Seychelles	39	49	34	122.0	12.00
Sierra Leone	20	26	9	55.0	31.00
Singapore	47	52	52	151.0	11.00
Slovakia	24	17	41	82.0	20.00
Slovenia	44	74	58	176.0	11.00
Solomon Islands	31	8	22	61.0	32.00
Somalia	20	3	2	25.0	39.00
South Africa	35	44	46	125.0	16.00
South Georgia South Sandwich Islands	0	0	0	0.0	0.00
Spain	45	73	52	170.0	10.00
Sri Lanka	40	42	51	133.0	23.00
Sudan	30	41	32	103.0	25.00
Suriname	38	57	24	119.0	14.00
Svalbard	0	0	0	0.0	0.00
Swaziland	10	48	23	81.0	11.00
Sweden	45	37	62	144.0	24.00
Switzerland	38	36	61	135.0	19.00
Syria	28	52	35	115.0	11.00
Taiwan	0	0	0	0.0	0.00
Tajikistan	32	62	40	134.0	17.00
Tanzania	35	36	23	94.0	31.00
Thailand	39	60	52	151.0	14.00
Timor-Leste	33	11	28	72.0	22.00
Togo	31	33	19	83.0	29.00
Tokelau	8	0	0	8.0	0.00
Tonga	22	65	32	119.0	19.00
Trinidad & Tobago	38	71	53	162.0	7.00
Tunisia	40	55	49	144.0	13.00
Turkey	41	61	51	153.0	11.00
Turkmenistan	25	62	32	119.0	9.00
Turks & Caicos Islands	16	0	0	16.0	1.00
Tuvalu	4	17	8	29.0	18.00
Uganda	31	37	32	100.0	31.00
Ukraine	35	68	57	160.0	8.00

United Arab Emirates	35	54	63	152.0	11.00
United Kingdom	45	36	69	150.0	15.00
United States	44	34	72	150.0	16.00
United States Minor Outlying Islands	0	0	0	0.0	0.00
United States Virgin Islands	35	10	0	45.0	20.00
Uruguay	42	56	62	160.0	21.00
Uzbekistan	37	27	44	108.0	16.00
Vanuatu	38	8	14	60.0	27.00
Venezuela	44	66	47	157.0	10.00
Vietnam	42	65	45	152.0	16.00
Wallis and Futuna	0	0	0	0.0	0.00
Western Sahara	0	0	7	7.0	0.00
Yemen	29	42	28	99.0	13.00
Zambia	28	42	28	98.0	30.00
Zimbabwe	35	51	30	116.0	27.00