NOVA

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World in the Balance

NOVA examines recent trends in population worldwide and explores the environmental implications of countries undergoing industrialization.

THE PEOPLE PARADOX

The program:

- reveals that birthrates are declining in many parts of the world, particularly in industrialized nations.
- conveys that populations are still rapidly growing in developing countries, where demand for food and water is higher than supply.
- examines how population growth or decline will affect different countries.
- profiles the population challenges of India, Kenya, and Japan.
- relates how women in India do not have access to birth control or adequate medical care and often die in childbirth.
- shows how orphans in sub-Saharan Africa struggle to survive after their parents die from AIDS.
- describes the development of a microbicide that may give women the ability to protect themselves from sexually transmitted diseases such as HIV.
- explores the problems Japan will encounter in the future when its labor force shrinks and there are no longer women at home to care for the elderly.

CHINA REVS UP

The program:

- examines environmental problems expected to develop as China becomes increasingly industrialized.
- describes China as a country encompassing a quarter of the world's population.
- highlights the fact that many people in China will be changing from an agrarian to an urban lifestyle in the next few decades.
- reports that China burns more coal than any other nation, a source of pollutants and a greenhouse gas.
- explores what might happen when more cars are purchased in China.
- recounts the government policy enacted in 1979 prohibiting Chinese couples from having more than one child.
- examines how population growth, affluence, and technology may affect global warming.
- discusses how improvements in technology can reduce carbon emissions.

BEFORE WATCHING

1 Ask students to estimate how many people live in the United States (about 290 million). How many people do students think live in the world (approximately 6 billion 360 million). Tell them that the world population in 1980 was 4.4 billion, and ask students what they think might be some of the consequences of a rapidly growing population.

2 Countries worldwide are facing different population challenges. Organize the class into three groups and have each group take notes on the challenges and population pyramids of India, Kenya, and Japan.

AFTER WATCHING

1 Discuss with students the various challenges facing the populations of India, Kenya, and Japan. What are the issues facing each country? What does the population pyramid for each country look like and why? How might each country's issues be addressed?

2 In 2050, there will be approximately nine billion people in the world, according to the most widely accepted estimate. Ask students what problems this might create for developing countries. What challenges will industrialized nations face? What problems will a nation like Japan, with a declining population, face?

3 As Earth's population expands, additional resources are needed to support the additional people. Ask students what kinds of actions could be taken by individuals to conserve Earth's resources. What are some actions that could be taken in each student's home or community? What can countries do to use the available land, food, and water resources more efficiently?

CLASSROOM ACTIVITY

Objective

To calculate how long it takes a country's population to double in size and to investigate factors affecting growth rate.

Materials for each team

- copy of the "Double Up" student handout
- copy of the "Calculating Population Growth" student handout
- copy of the "Growth Rates Worldwide" student handouts
- calculator
- graph paper
- access to print and Internet resources

Procedure

1. Since 1800, human population has grown from one billion to six billion people. Over the next half century, that number is projected to rise to nine billion. Tell students that in this activity they will investigate how long it takes the populations of different countries and territories to double.
2. Before class, refer to the "Growth Rates Worldwide" student handouts to create a list of six to eight countries for each team. Try to make sure that each team's list includes countries with a range of growth rates and that the class data set represents countries on all of the continents (excluding Antarctica, which has no indigenous population). Choose countries with a growth rate of more than 0.044 to ensure that the rate will double in a reasonable time frame (Norway, with a rate of 0.044, takes 160 years to double; Japan, with a rate of 0.011, takes 630 years). See Activity Answer on page 5 for some sample doubling rates. Don't choose countries with negative growth rates as they will never double.
3. Organize the class into teams of four and provide copies of the student handouts and other materials to each team. Assign each team its set of countries.
4. Define the meaning of growth rate: the increase in a country's population during a period of time expressed as a percentage of the population at the start of that time. For example, if a town had 75 people in 1980 and 100 people in 1981, the growth rate for the year would be 33 percent.

STANDARDS CONNECTION

The "Double Up" activity aligns with the following National Science Education Standards and Principles and Standards for School Mathematics:

Grades 5–8
Science Standard F:
Science in Personal and Social Perspectives
Populations, resources, and environments

- When an area becomes overpopulated, the environment will become degraded due to the increased use of resources.
- Causes of environmental degradation and resource depletion vary from region to region and from country to country.

Mathematics Standards:
Algebra
Data Analysis and Probability

Video is not required for this activity.

Classroom Activity Author
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CLASSROOM ACTIVITY

5 Explain to students that they will be using 10-year compounded growth rates to determine when each country's population will double. The 10-year growth rate is based on annual growth rates for 2003 from the U.S. Bureau of Census International Database. The starting population for each country will be 50 individuals, and for this activity the growth rate will be assumed to be constant.

6 Use the steps on the "Calculating Population Growth" student handout to demonstrate how to calculate future population sizes using the growth rate data.

7 After teams have doubled the populations of all of their assigned countries, have teams graph their countries' population growths. Have students put the number of years on the *x*-axis in increments of 10 and the number of individuals on the *y*-axis in increments of five. Then ask students to draw the best-fit curve.

8 If necessary, help students see that population growth is not a linear function; i.e., it produces a curved graph rather than a straight-line graph. Have teams answer the questions on their student handouts and hold a class discussion about their conclusions.

9 Create a class histogram on the blackboard, posterboard, or an overhead to compare population doubling for each country. The histogram will need to have an upper time value of the country that takes the longest to double and should have an upper population size value of 150. Ask each team to represent each of its countries with a data point and an abbreviation of the country's name. Examine the histogram with students. Where do most of the countries in the class data set fall on the histogram? What else do students observe about the histogram? (Remind students that this does not represent all the world's countries.)

10 Have students brainstorm a list of factors they think might affect growth rate (e.g., birthrate, death rate, access to medical care, nutrition, immigration, education, and income).

11 Ask students to choose the four lowest and the four highest growth rate countries among their data sets or from the larger data table representing all the countries. Organize the class into teams belonging to two groups: Have one group use print and Internet resources to research some factors that contribute to low growth rates and the possible environmental, social, and economic impacts on the people within those populations; have the other group research factors contributing to high growth rates and the corresponding impacts on people in its populations. Have each team write a two-page report on its findings. Students can find some of this information in the CIA World Factbook, the World Bank Group Data Profile tables, and CountryReports.org at
www.cia.gov/cia/publications/factbook/
www.worldbank.org/data/countrydata/countrydata.html
www.countryreports.org/

STANDARDS CONNECTION (CONT.)

Grades 9–12
Science Standard F:
Science in Personal and Social Perspectives
Population growth

- Populations grow or decline through the combined effects of births and deaths, and through emigration and immigration. Populations can increase through linear or exponential growth, with effects on resource use and environmental pollution.
- Various factors influence birthrates and fertility rates, such as average levels of affluence and education, importance of children in the labor force, education and employment of women, infant mortality rates, cost of raising children, availability and reliability of birth control methods, and religious beliefs and cultural norms that influence personal decisions about family size.

Mathematics Standards:
Algebra
Data Analysis and Probability

CLASSROOM ACTIVITY

12 To conclude the lesson, discuss with students some of the factors affecting growth rates in the countries they researched. Do students see any commonalities among low-growth rate countries? Among high-growth rate countries? What are some of the differences between the factors among low-growth rate and high-growth rate countries?

13 As an extension, have students choose countries with a negative growth rate and calculate the time it takes for a population to decrease to half its original size given an initial population size of 100 individuals. Then have them research reasons for negative growth rates.

ADDITIONAL ACTIVITIES

Find two social studies-based activities—one on global warming and the other on U.S. immigration—in our Educational Role Plays at **www.pbs.org/nova/worldbalance/roleplay/**

ACTIVITY ANSWER

Countries with high growth rates double more quickly than those with low growth rates. High-growth rate countries have higher birthrates and lower deathrates. The greater the difference between birthrate and deathrate, the more quickly the population grows.

The following table provides sample results for the amount of time it takes for a population to double. The numbers in parentheses are the calculated values for total population size at that period in time. All numbers are rounded up.

Sample Population Doubling Rates

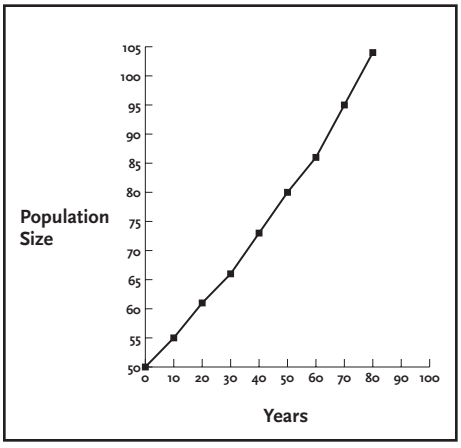
Country	10-year compounded growth rate	Population doubles after approximately:
Australia	0.097	80 years (105)
Bangladesh	0.226	40 years (113)
Brazil	0.121	70 years (111)
Cameroon	0.221	40 years (111)
Canada	0.098	80 years (106)
Cayman Islands	0.317	30 years (114)
Chad	0.353	30 years (124)
China*	0.062	120 years (103)
Colombia	0.168	50 years (109)
Costa Rica	0.167	50 years (108)
Egypt	0.204	40 years (105)
Ghana	0.155	50 years (103)
Guatemala	0.300	30 years (110)
Guinea	0.264	30 years (101)
Haiti	0.180	50 years (114)
Hong Kong	0.128	60 years (103)
India	0.157	50 years (104)
Kenya	0.134	60 years (106)
Kuwait	0.389	30 years (134)
Madagascar	0.348	30 years (122)
Malta	0.075	100 years (103)
Mayotte	0.516	20 years (115)
Mexico	0.126	60 years (102)
Nepal	0.251	40 years (122)
New Zealand	0.114	70 years (106)
Norway	0.044	160 years (100)
Pakistan	0.220	40 years (111)
Saudi Arabia	0.379	30 years (131)
Singapore	0.400	30 years (137)
Somalia	0.402	30 years (138)
Uganda	0.339	30 years (120)
United States	0.096	80 years (104)
Uruguay	0.082	90 years (102)
Vietnam	0.137	60 years (108)

***Note:** China has a government-controlled birthrate.

Most student graphs should indicate that growth rate is a curve rather than a straight line; however, for countries with a growth rate close to zero (i.e., Germany, Japan, and France), students may not have enough data points to show a curved line. In these cases, you may wish to have students calculate and plot more data points and/or extrapolate the shape of the line based on other graphs. In this activity, doubling the growth rate results in the population size doubling in approximately half as much time.

Greenland and South Africa have the lowest 10-year compounded growth rate (0.001) and would take 6,890 years to double. Montserrat has the highest growth rate (0.553) and would take 20 years to double. A leader of a low-growth rate country might be concerned with having enough workers to sustain a strong economy and support the nation's seniors; a leader of a high-growth rate country might be concerned with providing adequate services—such as education, health care, and jobs—for a large population. World population would double in about 60 years if the projected 10-year growth rate is 0.123.

Sample Graph: United States



There are numerous factors that contribute to low and high growth rates. Tell students that while it is possible to generalize factors affecting population size, these generalizations may not be accurate. Each country has a unique set of circumstances. Countries with negative or low population growth rates tend to have low fertility rates and low female illiteracy rates. In the case of Botswana, however, a high fertility rate is offset by a high infant mortality rate. Countries with relatively high population growth may have high fertility rates and high female illiteracy rates (as in the case of Chad).

Other factors that influence the population growth rate of a country include life expectancy, health care, access to fresh water, sanitation, and level of technology.

LINKS AND BOOKS

Links

NOVA Web Site—
World in the Balance
www.pbs.org/nova/worldbalance/
In this companion Web site to the NOVA program, find the latest population figures, see how the world's population has grown, learn about how rising populations affect the environment, test your understanding of population trends, read interviews with experts, discover ways to get involved, and more.

Earth Day Network
www.earthday.net/goals/issues.stm
Explains the major threats to our environment, including water pollution, deforestation, and global warming, and offers opportunities for taking action.

Ecological Footprint Quiz
myfootprint.org
Estimates how much land and water you need to support your lifestyle. Enables you to compare your footprint to other people's and to the amount of resources available on Earth.

Population Growth Rate
www.worldbank.org/depweb/english/modules/social/pgr/
Provides a general background on factors affecting population growth rate and some of the problems that may develop if a population grows too quickly.

Population Issues Overview
www.unfpa.org/issues/index.htm
Offers an overview of some of the factors related to population issues such as access to family planning, poverty, and lack of education and choices for women.

Population Reference Bureau
www.prb.org/
Contains articles, datasheets, and reports regarding population issues. Information is arranged by regions and by topics, including family planning, gender, and health.

Six Billion and Beyond
www.pbs.org/sixbillion/
Includes a study guide on population and the perspectives of people from six different countries.

The World Bank Group: Data by Country
www.worldbank.org/data/countrydata/countrydata.html
Provides data such as population, fertility rate, literacy rate, and other figures related to population for different countries, regions, and income levels.

World POPClock Projection
www.census.gov/cgi-bin/ipc/popclockw
Gives the U.S. Bureau of the Census' daily estimate for the total world population and provides a link for more POPClocks.

World Population Prospects
esa.un.org/unpp/
Generates population statistics, for the world or for individual countries, for a given time period. Also gives a list of developed and less-developed countries.

Books

Bouvier, Leon F. and Jane T. Bertrand.
World Population: Challenges for the 21st Century.
Santa Ana, CA: Seven Locks Press, 1999.
Provides a history of population growth and covers issues ranging from immigration to family planning.

Fyson, Nance Lui.
World Population.
New York: F. Watts, 1998.
Examines the effects of agricultural, industrial, and medical factors on population growth.

Mazur, Laurie Ann.
Beyond the Numbers: A Reader on Population, Consumption, and the Environment.
Washington, DC: Island Press, 1994.
Presents essays reflecting eight population and consumption issues. Topics include gender equality, family planning, and reproductive rights.

Menzel, Peter.
Material World: A Global Family Portrait.
San Francisco: Sierra Club Books, 1994.
Presents the material possessions of average families throughout the world, featuring a photo of each family posing outside their home with all of their material goods surrounding them.

Newbold, K. Bruce.
Six Billion Plus: Population Issues in the Twenty-First Century.
Lanham, MD: Rowman & Littlefield Publishers, 2002.
Explores various impacts on population including HIV and AIDS, fertility, and immigration.

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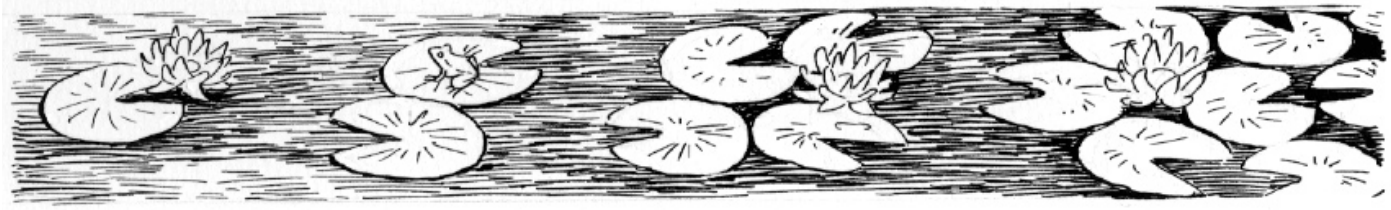
Double Up



"At first there is only one lily pad in the pond, but the next day it doubles, and thereafter each of its descendants doubles. The pond completely fills up with lily pads in 30 days. When is the pond exactly half full? Answer: on the 29th day."
—Old French riddle

Unlike the lily pads in the French riddle, the human population does not double in size every day. However, it is increasing more quickly than you might suspect. In this activity, you will have the chance to investigate how quickly the populations in different countries are increasing.

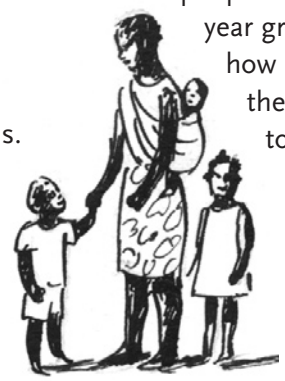
Procedure

1. Your team will be assigned six to eight countries. Find each country's 10-year growth rates on the "Growth Rates Worldwide" handout. (The 10-year growth rate tells you the rate at which the population of the country increases every 10 years.)
2. Based on each country's growth rate, make a prediction as to how many decades (10-year periods) it might take for each country's population to double in size. Record your predictions on a separate sheet of paper.
3. Use an initial population of 50 individuals for each country. Follow the steps listed on your "Calculating Population Growth" handout to calculate how large each country's population will be after 10 years. Record the new population size on a separate sheet of paper.
4. Repeat the process until each country's population size doubles.
5. Use your results to make a graph that shows how the population for each country increases over 10-year periods. Graph the number of years on the *x*-axis and the number of people on the *y*-axis. Draw the best-fit curve.

Questions

Write your answers on a separate sheet of paper.

1. Compare your results with your original predictions. How do they compare?
2. Compare your results with those of other teams. How does increasing or decreasing the growth rate affect how quickly the population size increases or decreases?
3. Use your "Growth Rates Worldwide" handouts to find the country or territory with the lowest growth rate and the country or territory with the highest growth rate. Use your formula to calculate how long it would take each one to double. How do they compare to the countries in your original data set? If you were a leader of either of those countries, what would be your concerns about your country's growth rate?
4. The world population is currently estimated at roughly six billion people. If the projected 10-year growth rate is 0.123, how long will it take for the world population to double?



Calculating Population Growth

Use the instructions on this handout to calculate population growth estimates for your assigned countries.

Procedure

1. Multiply the initial population by the growth rate. This will give you the number of individuals that are added to the population in a 10-year period. (This number should be rounded up, since partial individuals do not exist in the real world.)
2. Add the result from Step 1 to the initial population to get the new population after 10 years.
3. For the next 10-year period, the new population size becomes the starting population value. Multiply the new population size by the growth rate. As before, add the resulting number of individuals to the starting population to calculate the new population size after 20 years.
4. Repeat the process until each country's population has doubled. Note that because you are looking a 10-year periods, the population may not be exactly double in size at the end of a period. For instance, in the example given, you would stop after 30 years, when the population reaches 124.

Sample Calculation

Here is a sample calculation for a country with a 10-year growth rate of .25. The country's population doubles soon after 20 years.

	Starting Population	10-year Growth rate	Number of New Individuals	New Population Size
Initial	50	.25	12.5 (13)	63
After 10 years	63	.25	15.75 (16)	79
After 20 years	79	.25	19.75 (20)	99
After 30 years	99	.25	24.75 (25)	124

Growth Rates Worldwide

The following are 10-year compounded growth rates for countries worldwide. The 10-year growth rate is based on annual growth rates for 2003 from the U.S. Bureau of the Census International Database. The countries, islands, and territories are grouped by continents.

North America, Central America, and the Caribbean

Country	10-year growth rate
Belize	0.273
Canada	0.098
Costa Rica	0.167
El Salvador	0.196
Guatemala	0.300
Honduras	0.258
Mexico	0.126
Nicaragua	0.223
Panama	0.144
United States of America	0.096
Islands and Territories	**10-year growth rate**
Anguilla	0.244
Antigua and Barbuda	0.066
Aruba	0.056
Bahamas	0.079
Barbados	0.039
Bermuda	0.075
Cayman Is.	0.317
Cuba	0.037
Dominica	-0.061
Dominican Republic	0.145
Greenland	0.001
Grenada	0.008
Guadeloupe	0.104
Haiti	0.180
Jamaica	0.063
Martinique	0.088
Montserrat	0.553
Netherlands Antilles	0.093
Puerto Rico	0.052
St. Kitts & Nevis	0.013
St. Lucia	0.133
St. Pierre & Miquelon	0.031
St. Vincent & the Grenadines	0.035
Trinidad & Tobago	-0.066
Turks & Caicos Is.	0.363
Virgin Is. (U.S.)	-0.002
Virgin Is. (British)	0.231

South America

Country	10-year growth rate
Argentina	0.110
Bolivia	0.175
Brazil	0.121
Chile	0.110
Colombia	0.168
Ecuador	0.209
Guyana	0.045
Paraguay	0.285
Peru	0.173
Suriname	0.038
Uruguay	0.082
Venezuela	0.158

Growth Rates Worldwide

Europe

Country	10-year growth rate
Albania	0.053
Andorra	0.111
Austria	0.016
Belarus	-0.012
Belgium	0.018
Bosnia-Herzegovina	0.049
Bulgaria	-0.091
Croatia	0.032
Czech Republic	-0.005
Denmark	0.036
Estonia	-0.048
Finland	0.021
France	0.042
Germany	0.004
Gibraltar	0.022
Greece	0.021
Hungary	-0.025
Iceland	0.050
Ireland	0.121
Italy	0.011
Latvia	-0.071
Liechtenstein	0.093
Lithuania	-0.022
Luxembourg	0.138
Macedonia	0.040
Malta	0.075
Moldova	0.013
Monaco	0.045
Netherlands	0.062
Norway	0.044
Poland	0.000
Portugal	0.018
Romania	-0.011
San Marino	0.146
Serbia & Montenegro	0.007
Slovakia	0.013
Slovenia	0.014
Spain	0.016
Sweden	0.018
Switzerland	0.062
Ukraine	-0.067
United Kingdom	0.030

Islands and Territories	10-year growth rate
Faroe Is.	0.072
Guernsey	0.035
Isle of Man	0.054
Jersey	0.041

Africa

Country	10-year growth rate
Algeria	0.177
Angola	0.216
Benin	0.337
Botswana	-0.054
Burkina Faso	0.293
Burundi	0.241
Cameroon	0.221
Central African Republic	0.174
Chad	0.353
Congo (Brazzaville)	0.164
Congo (Kinshasa)	0.331
Cote d'Ivoire	0.237
Djibouti	0.235
Egypt	0.204
Equatorial Guinea	0.273
Eritrea	0.136
Ethiopia	0.215
French Guiana	0.268
Gabon	0.285
Gambia	0.348
Ghana	0.155
Guinea	0.264
Guinea-Bissau	0.221
Kenya	0.134
Lesotho	0.020
Liberia	0.181
Libya	0.267
Madagascar	0.348
Malawi	0.244
Mali	0.321
Mauritania	0.333
Morocco	0.177
Mozambique	0.148
Namibia	0.160
Niger	0.307
Nigeria	0.283
Rwanda	0.200
Sao Tome & Principe	0.368
Senegal	0.287
Sierra Leone	0.336
Somalia	0.402
South Africa	0.001
Sudan	0.307
Swaziland	0.086
Tanzania	0.186
Togo	0.264
Tunisia	0.115
Uganda	0.339
Western Sahara	0.254
Zambia	0.163
Zimbabwe	0.086

Islands and Territories	10-year growth rate
Cape Verde Is.	0.082
Comoros	0.339
Mauritius	0.087
Mayotte	0.516
Reunion	0.157
St. Helena	0.069
Seychelles	0.047

Growth Rates Worldwide

Asia

Country	10-year growth rate
Afghanistan	0.394
Armenia	-0.007
Azerbaijan	0.045
Bahrain	0.173
Bangladesh	0.226
Bhutan	0.235
Brunei	0.219
Burma	0.053
Cambodia	0.196
China	0.062
Cyprus	0.057
East Timor	0.235
Gaza Strip	0.464
Georgia	-0.051
India	0.157
Indonesia	0.163
Iran	0.114
Iraq	0.316
Israel	0.147
Japan	0.011
Jordan	0.316
Kazakhstan	0.017
Korea (North)	0.112
Korea (South)	0.068
Kuwait	0.389
Kyrgyzstan	0.156
Laos	0.274
Lebanon	0.142
Malaysia	0.202
Mongolia	0.152
Nepal	0.251
Oman	0.394
Pakistan	0.220
Philippines	0.209
Qatar	0.327
Russia	-0.030
Saudi Arabia	0.379
Singapore	0.400
Sri Lanka	0.086
Syria	0.274
Taiwan	0.067
Tajikistan	0.234
Thailand	0.099
Turkey	0.123
Turkmenistan	0.198
United Arab Emirates	0.168
Uzbekistan	0.175
Vietnam	0.137
Yemen	0.400
West Bank	0.383
Islands and Territories	**10-year growth rate**
Maldives	0.332
Special Admistrative Regions	
Hong Kong S.A.R. (China)	0.128
Macau S.A.R. (China)	0.088

Australia and Oceania

Country	10-year growth rate
Australia	0.097
New Zealand	0.114
Papua New Guinea	0.261
Islands and Territories	**10-year growth rate**
American Samoa	0.017
Cook Is.	0.172
Fiji	0.151
French Polynesia	0.174
Guam	0.164
Kiribati	0.251
Marshall Is.	0.255
Micronesia, Fed. States of	0.004
Nauru	0.207
New Caledonia	0.147
Northern Mariana Is.	0.317
Palau	0.165
Samoa	-0.026
Solomon Is.	0.322
Tonga	0.207
Tuvalu	0.152
Vanuatu	0.174
Wallis & Futuna Is.	0.107