A World Map of Organic Agriculture

John Paull
Institute of Social and Cultural Anthropology, University of Oxford
Email: john.paull@anthro.ox.ac.uk
Tel: +44 (0)1865-589-113

Benjamin Hennig
Department of Geography, University of Sheffield
Email: b.hennig@sheffield.ac.uk

Abstract

This paper presents a world map of organic agriculture. A Gall-Peters projection map of the world is taken as the reference map (where map areas are proportional to territorial areas). Applying the area of organic agriculture to countries, the World Map of Organic Agriculture presents countries as proportional in size to their share of the total of world organic hectares (such a map can be referred to as an equal-area cartogram or a density-equalising map). The World Map of Organic Agriculture accounts for 37.2 million hectares of organically managed agricultural land (certified organic and in-conversion organic) from 160 countries, and here distributed across the 200 territories of the reference map. The World Map of Organic Agriculture visually reveals global contiguity and regional relationships among and between the territories of the world, and highlights the regional strengths and weaknesses of the global diffusion of organic agriculture. The World Map of Organic Agriculture is generated by the Worldmapper GIS algorithm developed at the University of Sheffield as a cartographic visualisation tool. It is the first Worldmapper cartogram to proportionately represent Falkland Islands (Malvinas).

Keywords: Global organic farming, certified organic agriculture, equal-area cartogram, density-equalizing map, Worldmapper, Geographic Information Systems (GIS).

1. Introduction

1.1. Maps

The assertion that "A picture is worth ten thousand words" was presented by Fred Barnard in 1927 as a Chinese proverb, and it has by now become a maxim of modern advertising and communications. 'Visual' is the dominant learning modality for many, and presenting information visually enhances recall even where the visual modality is not an individual's dominant learning modality (e.g. Constantinidou & Baker, 2002).

Visual images can carry a potency that words can struggle to match. The picture of a terrified young Vietnamese girl running from a US napalm drop during the Vietnam War summed up, in a single image, the case against the war and the misery and injustice that words and statistics could barely, and perhaps never, match (Chong, 2001).

Alfred Korzbyski (1933) made two observations about maps. Firstly, that the map is not the territory, and secondly, that it is the similarity of the structure of the map to the territory that accounts

for its usefulness. The process of producing a map reduces the complexity of the territory to the simplicity of the map, and this is, by definition, a lossy process. A map conceals more than it reveals, and yet it is just what it reveals that makes it interesting and perhaps, as Korzbyski suggests, useful.

Maps possess an immediacy that is lacking in tables and narrative accounts. With his epic voyage of Antipodean discovery, Matthew Flinders (1774-1814) was the first to circumnavigate and chart the coast of Australia. His narrative account runs to 613 pages, whereas, in contrast, one map, his 'General Chart of Terra Australis or Australia', bears tangible and immediate witness to his great achievement (Flinders, 1814).

Maps most typically reduce a three dimensional territory to a two dimensional plane. This process introduces a controlled form of distortion since the surface of a ball, for example, cannot be represented on a sheet of paper without some degree of compromise and cartographic license. All maps have implicit biases, for example, positioning Australia somewhat arbitrarily in the lower half and Europe in the upper half. US maps of the world generally have the USA placed centrally, European maps typically place Europe along the central meridian, while Australian maps typically have Australia placed centrally. And consider, if Antarctica was a republic of a hundred million citizens they would surely be demanding some better projection than the typical ones that reduce Antarctica to a squiggle scratched along the bottom of world maps.

James Gall (1885) and Arno Peters (1983), among others, have argued for a world map that represents equal areas equally. This process is achieved effectively by sliding an imaginary cylinder over the world globe, migrating the counties to the surface of the cylinder (while conserving shape and size), then cutting open the cylinder vertically, and flattening it out (and choose a scale for reproduction). This process conserves territorial area in that equal map areas represent equal territorial areas. This process does not conserve inter-regional distances, so that distances between land masses are progressively exaggerated as the poles are approached; this is an artifact of transforming the surface of a sphere to a plane. Following previously entrenched conventions, Europe may still occupy a central meridian, north is up, and the equator cuts the map horizontally (Fig.1).

A cartographic challenge of long standing has been to create equal-area cartograms (Tobler, 2004) so that map areas are proportional to some territorial parameter. The Worldmapper project (worldmapper.org) of the University of Sheffield adopts a Gall-Peters world map as its reference map - with its equal map areas representing equal territorial areas, but otherwise adopting typical Euro-centric cartographic conventions of north as up, and with Europe centrally placed (Fig.1). The Worldmapper projections replace the Gall-Peters prescription of 'equal map areas represent equal territory areas' with 'equal map areas represent equal parameter densities' where the nominated parameter is any variable that has a measurable distribution across the domain of the map (e.g. the world or a particular country) and whose presence can be measured locally, for example, population, road deaths, or military spending. An algorithm developed by Gastner & Newman (2004) achieves the appropriate resizing, and, as they assert, "produces useful, elegant, and easily readable maps" (p.7499). Colours differentiate twelve regions consistently through Worldmapper maps, and different countries within regions are distinguished by different shades of the regional colour, while regional colours follow the rainbow from red through to violet, poorest to richest, with that ordering derived from the Human Development Report (UNDP, 2004) (Fig.1).

1.2. Organic Agriculture

Organic agriculture is a set of food production protocols that have developed in parallel with chemical agriculture, and as a response to it. Rudolf Steiner presented what is arguably the first organic agriculture course to an audience of 111 farmers and others, from six continental European countries, in 1924 in what is now the Polish village of Kobierzyce (then Koberwitz) (Paull, 2011a). The course was partly a response to the growing chemicalisation of agriculture, epitomised particularly by the Haber-Bosch process which was first demonstrated by Fritz Haber and Carl Bosch in 1909. This process was rapidly industrialised and commercialised for producing nitrogenous fertilisers, as well as

explosives, with a vast industrial complex to convert nitrogen and hydrogen to ammonia opening in 1913 at Oppau, Germany (Charles, 2005; Nobel Foundation, 1966; Paull, 2009; Smil, 2001). The Haber-Bosch process was a great commercial success, it continues to be so, and it offered farmers cheap synthetic nitrogenous fertiliser.

Farmers at Steiner's course formed the Agricultural Experimental Circle of the General Anthroposophical Society, to test and develop the ideas that Steiner had presented. Informed by the research of the Agricultural Experimental Circle, Ehrenfried Pfeiffer published *Bio-Dynamic Farming and Gardening* in 1938 in at least five language editions: Dutch, English, French, German and Italian (Paull, 2011b; Pfeiffer, 1938). Pfeiffer's book described to an international audience the practices of an agriculture differentiated from the prevailing paradigm of chemical agriculture.

Shortly after Pfeiffer's book appeared, Lord Northbourne (1940) published *Look to the Land* in England. The book is a manifesto of organic agriculture, it introduced the term 'organic farming', it endorsed the results of biodynamic farming without excluding other modes of practising organic agriculture, it defined a contest of "organic versus chemical farming" (p.81), and it laid the broad philosophical underpinnings for an agriculture differentiated from chemical agriculture (Paull, 2006).

The terminology and concepts of organic farming, and of eschewing synthetic fertilisers and pesticides for the production of food, rapidly proliferated internationally. Jerome Rodale founded the first 'organic' periodical *Organic Farming and Gardening* in USA in 1942. In Sydney, Australia, the first 'organic' society, the Australian Organic Farming and Gardening Society was founded in 1944 and others followed (Paull, 2008). Roland Chevriot, President of the French national farmer organisation, Nature et Progrès, called a meeting in Versailles in 1972 which led to the founding of the global organics advocacy group, the International Federation of Organic Agriculture Movements (IFOAM) (Paull, 2010a). The organics sector is reportedly now valued at US$60 billion per annum (Biofach, 2011) and organic agriculture statistics are reported from 160 countries (Willer & Kilcher, 2011).

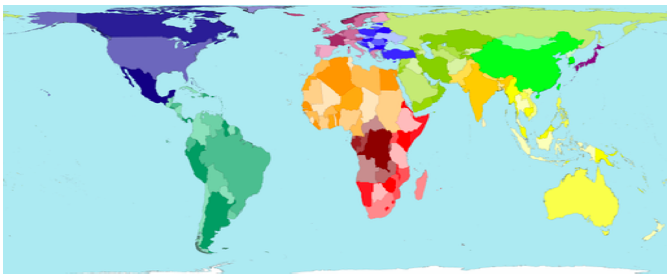
2. Methods

The Worldmapper algorithm (§2.1) was applied to the data set of world organic agriculture hectares (§2.2) to produce the World Map of Organic Agriculture. To marry the 160 territories reported by Willer & Kilcher (2001) with the 200 territories of the Worldmapper cartogram algorithm, the organic hectares of six islands (accounting for 3505 hectares in total) were transferred to their governing or administering states (refer Appendix 1 for the data set mapped). The World Map of Organic Agriculture accounts for 37,235,195 organic agriculture hectares which is the aggregate of all the territorially-attributed organic agriculture hectares of Willer & Kilcher (but is slightly different from their stated total of 37,232,127 organic agriculture hectares where 3068 hectares appear to be territorily-unattributed).

2.1. World Map

A method for producing a density-equalizing map was described by Gastner & Newman (2004) and this is the method used. The Worldmapper project (worldmapper.org) relies on a world map comprising 200 territories and an algorithm to apply the variable values (in this case organic agriculture hectares) to the corresponding territories so that the territories expand or contract to achieve an equal density of the variable across the territories within the domain of the map (in this case the world map). The reference map, with equal territorial areas represented by equal map areas, appears as Figure 1.

Figure 1: Reference Map of the World - Gall-Peters projection



Source: www.worldmapper.org

2.2. Data Set of Organic Agriculture

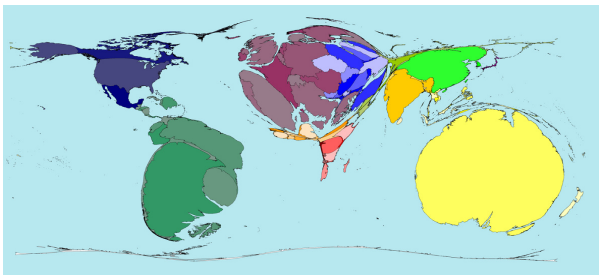
Data sets of worldwide organic agriculture hectares have been published annually, as tables, since 2000 (viz. Willer & Yussefi, 2000). The present paper uses the data set published in 2011 by Willer & Kilcher (2011) which reported data from 160 territories. Data sources for that 2011 data set are various, and include government departments and certifying agencies (pp.268-286). The data are stated to be variously from: 2004; 2005; 2006; 2007; 2008; 2008/2009; Oct 2008-Sept 2009; 2009 [most commonly]; 2009/2010; and June 2010 (pp.234-237). The data set is of "organic agricultural land (including in-conversion areas)" (p.29), however Willer & Kilcher state that "some countries provided only data on the fully converted area, others only on the total organically managed agricultural land" (p.29).

The data set of organic agriculture hectares relies on the reportage of third parties who are not necessarily 'at arms length' since, for example, they may be local organic certifiers. Survey respondents may under-report for reasons of, for example, ignorance or confidentiality; they may over-report, for example, to intentionally inflate figures, or because an enterprise that is certified organic may be certified by several certifiers to gain access to different markets and may thereby be counted several times in aggregated data.

3. Results

The density-equalising map for worldwide organic agriculture hectares is presented in Figure 2. Equal map areas (land masses) represent equal areas of organic agriculture; i.e. the density of organic hectares is constant across territories.

Figure 2: Word Map of Organic Agriculture



4. Discussion and Conclusion

Equal-density cartograms are a tool for presenting a fresh view of tabulated geographic data sets. Tobler (2004, p.58) makes the point that "The most common use of cartograms is solely for the display and emphasis of a geographic distribution, as a contrast to the usual geographic map".

The World Map of Organic Agriculture illustrates the great unevenness of the global uptake of organic agriculture. The map is dominated by the presence of Australia which appears especially bloated, and this reflects its world leadership position in terms of its number of organic agriculture hectares. South America has a strong presence accounted for in large measure by three countries, Argentina, Brazil and Uruguay. Europe collectively has a strong presence with substantial contributions from many states, and led by Spain, Italy, Germany, UK, France, and Austria. China and India dominate the Asian representation. Africa has an eviscerated presence, Russia appears anorexic, and the Middle East is emaciated, in each case reflecting the poor diffusion of organic agriculture into these regions - and perhaps the great opportunities for future organic penetration into these territories. The map presence of the Falkland Islands (Malvinas) reflects their recent commitment to the adoption of organics (BFA, 2009) and the newfound status of the Falkland Islands as a current world leader with 36% of its agricultural land classified as organic (Paull, 2011c).

The mechanics of the equal-density cartogram mean that, for future-year maps, a country's increment in organic hectares will appear as an increment in size in a future map, provided its percentage increase in organic hectares is greater that the global percentage increase. For the past decade Australia has increased its organic hectares at a slower rate than the global rate of organic hectares increase - if that trend were to persist then Australia would appear smaller in future maps. In contrast, China and India, for example, have an rate of increase much higher than the global average over the past decade, and if this trend were to persist then a future map of organic agriculture would reflect this with larger map-presences for these countries (decadal rates of increase derivable from data: Willer & Kilcher, 2011; & Willer & Yussefi, 2001).

Oscar Wilde (1891, p.13) observed that: "A map of the world that does not include Utopia is not worth even glancing at, for it leaves out the one country at which Humanity is always landing. And when Humanity lands there, it looks out, and, seeing a better country, sets sail. Progress is the realisation of Utopias". A world conversion to organic agriculture is an aspiration of the umbrella organisation representing the organics sector (IFOAM, 2006). So, in some senses, the World Map of Organic Agriculture honours Wilde's injunction by presenting progress towards an organics utopia, an Otopia (Paull, 2010b), while also highlighting the abundance of opportunities for the uptake and further growth of organic agriculture.

Acknowledgements

The World Map of Organic Agriculture relies on data reported by a wide variety of organic certifiers and others and collected and published by FiBL (Willer & Kilcher, 2011), and on the method for producing density-equalising maps proposed by Gastner & Newman (2004) and implemented by the Worldmapper project and the SASI (Social and Spatial Inequalities) Group of the University of Sheffield. Open source high resolution image files of Figure 2 are available for download at http://ora.ox.ac.uk/objects/uuid%3Aab89bad3-13cf-40b7-8c58-396d7e36e3ee

References

[1] Barnard, F. R. (1927). Chinese proverb: One picture is worth ten thousand words - Make a cake for Bobby. *Printers' Ink, 10 May*, 114-115.

[2] BFA. (2009). Organic farming in the Falkland Islands. *Organic-Market.Info, Lauterbach, Germany, 3 July*.

[3] Biofach. (2011). Global Organic Sales Approaching 60 Billion US Dollars. *Biofach Newsletter, 239*(7 January).

[4] Charles, D. (2005). *Master Mind: The rise and fall of Fritz Haber, the Nobel laureate who launched the age of chemical warfare*. New York: Ecco, HarperCollins Publishers.

[5] Chong, D. (2001). *The Girl in the Picture: The Story of Kim Phuc, the Photograph, and the Vietnam War*. London: Penguin.

[6] Constantinidou, F., & Baker, S. (2002). Stimulus modality and verbal learning in normal aging. *Brain and Language, 82*(3), 296-311.

[7] Flinders, M. (1814). *A Voyage to Terra Australis: Undertaken for the purpose of completing the discovery of that vast country, and prosecuted in the years 1801, 1802, and 1803, Vols I & II* (2004 edition ed.): Project Gutenberg eBook.

[8] Gall, J. (1885). Use of cylindrical projections for geographical, astronomical, and scientific purposes. *Scottish Geographical Magazine, 1*(4), 119–123.

[9] Gastner, M. T., & Newman, M. E. J. (2004). Diffusion-based method for producing density equalizing maps. *Proceedings of the National Academy of Sciences (PNAS), 101*(20), 7499-7504.

[10] IFOAM. (2006). *Principles of Organic Agriculture*. Bonn: International Federation of Organic Agriculture Movements (IFOAM).

[11] Korzybski, A. (1933). *Science and Sanity: An Introduction to Non-Aristotelian Systems and General Semantics*. Lancaster, PA: International Non-Aristotelian Library Publishing Company.

[12] Nobel Foundation. (1966). *Nobel Lectures, Chemistry 1922-1941*. Amsterdam, Netherlands: Elsevier Publishing.

[13] Northbourne, Lord. (1940). *Look to the Land*. London: Dent.

[14] Paull, J. (2006). The farm as organism: the foundational idea of organic agriculture. *Journal of Bio-Dynamics Tasmania, (80)*, 14-18.

[15] Paull, J. (2008). The lost history of organic farming in Australia. *Journal of Organic Systems, 3*(2), 2-17.

[16] Paull, J. (2009). A Century of Synthetic Fertilizer: 1909-2009. *Journal of Bio-Dynamics Tasmania*(94), 16-21.

[17] Paull, J. (2010a). From France to the World: The International Federation of Organic Agriculture Movements (IFOAM). *Journal of Social Research & Policy, 1*(2), 93-102.

[18] Paull, J. (2010b). The Future of Organic Agriculture: Otopia or Oblivion? *Innovative Science Editions, 1*, 11-14.

[19] Paull, J. (2011a). Attending the First Organic Agriculture Course: Rudolf Steiner's Agriculture Course at Koberwitz, 1924. *European Journal of Social Sciences, 21*(1), 64-70.

[20] Paull, J. (2011b). Biodynamic Agriculture: The journey from Koberwitz to the World, 1924-1938. *Journal of Organic Systems, 6*(1), 27-41.

[21] Paull, J. (2011c). Organics Olympiad 2011: Global Indices of Leadership in Organic Agriculture. *Journal of Social and Development Sciences, 1*(4), 144-150.

[22] Peters, A. (1983). *Die Neue Kartographie/The New Cartography*. (dual text: in German and English); Klagenfurt, Austria: Carinthia University; New York Friendship Press: Friendship Press.

[23] Pfeiffer, E. (1938). *Bio-Dynamic Farming and Gardening: Soil Fertility Renewal and Preservation* (F. Heckel, Trans.). New York: Anthroposophic Press.

[24] Rodale, J. I. (Ed.). (1942). *Organic Farming and Gardening*. Emmaus, Pennsylvania: Rodale Press, 1(1):1-16.

[25] Smil, V. (2001). *Enriching the Earth: Fritz Haber, Carl Bosch, and the Transformation of World Food Production*. Cambridge, USA: The MIT Press.

[26] Tobler, W. (2004). Thirty Five Years of Computer Cartograms. *Annals of the Association of American Geographers, 94*, 58-73.

[27] UNDP. (2004). *Human Development Report 2004: Cultural liberty in today's diverse world*. New York, NY: United Nations Development Programme (UNDP).

[28] Wilde, O. (1891). *The Soul of Man Under Socialism* (2008 edition ed.). Whitefish, MT: Kessinger Publishing.

[29] Willer, H., & Kilcher, L. (Eds.). (2011). *The World of Organic Agriculture: Statistics and Emerging Trends 2011*: Bonn: International Federation of Organic Agriculture Movements (IFOAM); Frick, Switzerland: Research Institute of Organic Agriculture (FiBL).
[30] Willer, H., & Yussefi, M. (Eds.). (2000). *Organic Agriculture World-Wide: Statistics and Perspectives*. Bad Durkheim, Germany: Stiftung Ökologie & Landbau (SÖL).
[31] Willer, H., & Yussefi, M. (Eds.). (2001). *Organic Agriculture Worldwide 2001: Statistics and Future Prospects*. Bad Durkheim, Germany: Stiftung Ökologie & Landbau (SÖL).

Appendix

Table 1: The data set on which the World Map of Organic Agriculture is based (*includes Faroe Islands (12 ha); ** inc. French Guinea (2651 ha); Guadeloupe (83 ha); Martinique (141 ha); Reunion (188 ha); *** inc. Channel Islands (430 ha)). Sources: country listing from worldmapper.org with Falkland Islands added; organic agriculture hectares data from Willer & Kilcher (2011).

Country	Organic Hectares
Afghanistan	63
Albania	500
Algeria	622
Andorra	2
Angola	2486
Antigua & Barbuda	0
Argentina	4397851
Armenia	600
Australia	12001724
Austria	518757
Azerbaijan	20339
Bahamas	0
Bahrain	0
Bangladesh	1162
Barbados	0
Belarus	0
Belgium	41459
Belize	1177
Benin	872
Bhutan	0
Bolivia	41004
Bosnia Herzegovina	580
Botswana	0
Brazil	1765793
Brunei Darussalam	0
Bulgaria	12320
Burkina Faso	14693
Burundi	350
Cambodia	10725
Cameroon	292
Canada	703678
Cape Verde	0
Central African Republic	0
Chad	0
Chile	82327
China	1853000
Colombia	42235
Comoros	1330
Congo	0
Cook Islands	4
Costa Rica	8058

Table 1: The data set on which the World Map of Organic Agriculture is based (*includes Faroe Islands (12 ha); ** inc. French Guinea (2651 ha); Guadeloupe (83 ha); Martinique (141 ha); Reunion (188 ha); *** inc. Channel Islands (430 ha)). Sources: country listing from worldmapper.org with Falkland Islands added; organic agriculture hectares data from Willer & Kilcher (2011). - continued

Cote d'Ivoire	17443
Croatia	14194
Cuba	14314
Cyprus	3816
Czech Republic	398407
Democratic Republic of Congo	6667
Denmark*	156445
Djibouti	0
Dominica	0
Dominican Republic	161098
DPR Korea	0
Ecuador	69358
Egypt	56000
El Salvador	6736
Equatorial Guinea	0
Eritrea	0
Estonia	95167
Ethiopia	122727
Falkland Islands	395935
Fed States of Micronesia	0
Fiji	100
Finland	166171
France**	680576
Gabon	0
Gambia	0
Gaza Strip & West Bank	1000
Georgia	1208
Germany	947115
Ghana	29140
Greece	326252
Greenland	0
Grenada	40
Guatemala	13300
Guinea	0
Guinea-Bissau	0
Guyana	4249
Haiti	54
Holy See	0
Honduras	11801
Hong Kong (China)	0
Hungary	140292
Iceland	6661
India	1180000
Indonesia	52133
Iraq	0
Ireland	47864
Islamic Republic of Iran	18353
Israel	6969
Italy	1106684
Jamaica	542
Japan	8817
Jordan	1053
Kazakhstan	134862
Kenya	4227
Kiribati	0

Table 1: The data set on which the World Map of Organic Agriculture is based (*includes Faroe Islands (12 ha); ** inc. French Guinea (2651 ha); Guadeloupe (83 ha); Martinique (141 ha); Reunion (188 ha); *** inc. Channel Islands (430 ha)). Sources: country listing from worldmapper.org with Falkland Islands added; organic agriculture hectares data from Willer & Kilcher (2011). - continued

Kuwait	0
Kyrgyzstan	11415
Lao People's Dem Republic	4878
Latvia	160175
Lebanon	3332
Lesotho	330
Liberia	0
Libyan Arab Jamahiriya	0
Liechtenstein	1005
Lithuania	129055
Luxembourg	3614
Macedonia FYR	1489
Madagascar	14069
Malawi	994
Malaysia	1582
Maldives	0
Mali	21681
Malta	26
Marshall Islands	0
Mauritania	0
Mauritius	6
Mexico	332485
Monaco	0
Mongolia	0
Morocco	3800
Mozambique	1556
Myanmar	555
Namibia	124
Nauru	0
Nepal	8059
Netherlands	51911
New Zealand	124463
Nicaragua	33621
Niger	355
Nigeria	8202
Niue	159
Norway	56737
Oman	39
Pakistan	20321
Palau	0
Panama	5244
Papua New Guinea	3321
Paraguay	51190
Peru	186314
Philippines	52546
Poland	367062
Portugal	209090
Puerto Rico	0
Qatar	0
Republic of Korea	13343
Republic of Moldova	32105
Romania	168288
Russian Federation	78449
Rwanda	3697
Saint Kitts & Nevis	0

Table 1: The data set on which the World Map of Organic Agriculture is based (*includes Faroe Islands (12 ha); ** inc. French Guinea (2651 ha); Guadeloupe (83 ha); Martinique (141 ha); Reunion (188 ha); *** inc. Channel Islands (430 ha)). Sources: country listing from worldmapper.org with Falkland Islands added; organic agriculture hectares data from Willer & Kilcher (2011). - continued

Saint Lucia	0
Samoa	9714
San Marino	0
Sao Tome & Principe	3591
Saudi Arabia	46635
Senegal	25351
Serbia & Montenegro	13264
Seychelles	0
Short Name	
Sierra Leone	72472
Singapore	0
Slovakia	145490
Slovenia	29388
Solomon Islands	3628
Somalia	0
South Africa	59562
Spain	1330774
Sri Lanka	21156
St Vincent & The Grenadines	0
Sudan	77798
Suriname	8
Swaziland	46
Sweden	391524
Switzerland	114050
Syrian Arab Republic	35439
Taiwan	2962
Tajikistan	70
Thailand	29597
Timor-Leste	24997
Togo	1789
Tonga	0
Trinidad & Tobago	0
Tunisia	167302
Turkey	325831
Turkmenistan	0
Tuvalu	0
Uganda	226954
Ukraine	271315
United Arab Emirates	373
United Kingdom***	722156
United Republic of Tanzania	72188
United States	1948946
Uruguay	930965
Uzbekistan	324
Vanuatu	8996
Venezuela	337
Viet Nam	14012
Western Sahara	0
Yemen	0
Zambia	7310
Zimbabwe	421