# Pacific Island Groundwater Vulnerability to Future Climates Dataset

# DATA DICTIONARY

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**Geocat 81575**

**Bibliographic reference:** Stewart, G., Walker, K., Fontaine, K., Dixon-Jain, P. & Norman, R. 2014. Pacific Island Groundwater Vulnerability to Future Climates Dataset. Geoscience Australia, Canberra. http://www.ga.gov.au/metadata-gateway/metadata/record/gcat_81575

## Pacific Island Groundwater Vulnerability to Future Climates Dataset

**Type** Polygon: ESRI shapefile /comma-separated values file (.csv)
**Scale** 1: 250,000
**Projection** World Mercator Projection, WGS 84 with central meridian 180 degrees longitude, standard parallels at 0 degrees latitude.

**Companion Report:** The full bibliographic reference for the companion report referred to in the Data Dictionary is: Dixon-Jain, P., Norman, R., Stewart, G., Fontaine, K., Walker, K., Sundaram, B., Flannery, E., Riddell, A., Wallace, L. 2014. Pacific Island Groundwater and Future Climates: First-Pass Regional Vulnerability Assessment. Record 2014/43. Geoscience Australia, Canberra. http://dx.doi.org/10.11636/Record.2014.043

| Field Name | Attribute Type | Case | Valid Values | Description and Lineage |
|---|---|---|---|---|
| **UniqueID** | Short integer | Numeric | | Unique ID assigned to each island within the dataset. This field can be used to join the ESRI shapefile polygon layer and the comma-separated values attribute table. |
| **Country** | String, 50 | Proper | Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Nauru, Niue, Palau, Papua New Guinea, Republic of Marshall Islands, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu | Country falling within the Pacific Islands study area. |
| **Island_Name** | String 40 | Mixed | | Island names were sourced primarily from Motteler (2006). Soluri and Woodson (1990), the AusAID map of the Pacific Islands (AUSLIG 1996), Vacher and Quinn (1997), and Google Earth/Maps (Google Inc. 2012) were used for clarification where required. An entry of 'Unknown' signifies islands with no known name. |
| **Area_km** | Double | Numeric | | Island areas in square kilometres, calculated for the verified polygon dataset using the 'calculate geometry' tool within ESRI ArcMap. |
| **Perimeter_km** | Double | Numeric | | Island perimeter in kilometres, calculated for the verified polygon dataset using the 'calculate geometry' tool within ESRI ArcMap. |

| Field Name | Attribute Type | Case | Valid Values | Description and Lineage |
|---|---|---|---|---|
| **Maximum_Width_km** | Double | Numeric | | Maximum island width in kilometres, calculated using ESRI ArcMap's 'zonal thickness' process (spatial analyst extension). This method converts the island polygon shapes into pixel cells of a specified size (50 m) and then calculates the thickness for each 'zone' (ESRI 2011). The calculated 'thickness' is the radius of the largest circle that can be drawn within an island polygon (see Appendix Figure C.1 of the companion report). Given the specified output cell size, this means that the smallest calculated island radius is 25 m i.e. island diameter (radius multiplied by two) of 50 m. The maximum island width is defined by the calculated diameter. |
| **Maximum_Width_Class** | String 50 | Mixed | <=0.5, 0.5-5.0, 5-50, >50, -9999 | Maximum Width class based on the 'Maximum_Width_km' field. Values of -9999 signify islands with no maximum width specified. |
| **Island_Type** | String, 255 | Proper | Low Carbonate, Limestone, Volcanic, Composite, Complex, Unknown | Type of island as defined in the companion report. The 5 island types include Low Carbonate, Limestone, Volcanic, Composite and Complex. A large volume of island type data were derived from the United Nations Environment Programme (UNEP) Island Directory (Dahl 1998-2006) as well as from a range of literature sources (New Hebrides Condominium Geological Survey 1969; Geological Map of the British Solomon Islands 1969; Jacobson & Kidd 1974; New Hebrides Condominium Geological Survey 1978; Van Der Brug 1984; Gale & Booth 1993; Vacher and Quinn 1997; SOPAC 2007; Google Inc. 2012) and expert opinion (I. Elliot, L. Kumar, R. McLean, P. Nunn, pers. comm. 2014). An entry of 'Unknown' signifies islands with no known type. |
| **Island_Type_Reference** | String, 255 | Mixed | | Reference source for assigned island type in 'Island_Type' field. |
| **Principal_Aquifer** | String, 50 | Mixed | Intergranular, Fissured Karst, Fissured Fractured, Not Assessed | The aquifer type of the principal aquifer of the island. A principal aquifer was assumed for each island type based on the aquifer with the greatest potential productivity (Section 3.3 of the companion report). An entry of 'Not Assessed' signifies an island with insufficient information to derive a principal aquifer. |
| **Groundwater_Flow_System** | String, 100 | Proper | Very Small, Local, Intermediate, Regional, Not Assessed. | Groundwater flow system of the principal aquifer of the island. The groundwater flow system (GFS) for each island was informed by the island type and the maximum island width (described in companion report Chapter 3 and summarised in columns 1-3 of Table 3.3). An entry of 'Not Assessed' signifies an island with insufficient information to derive a GFS. |

| Field Name | Attribute Type | Case | Valid Values | Description and Lineage |
|---|---|---|---|---|
| **Freshwater_Potential** | String, 50 | Capitals | GW,<br>GW AND SW,<br>NO GW OR SW,<br>Not Assessed | Potential freshwater sources on an island. Islands are classed as having: limited potential for fresh groundwater or surface water (NO GW OR SW); potential for fresh groundwater and no surface water (GW); or potential for fresh groundwater and surface water (GW AND SW). Rules were applied to determine which islands had potential for fresh groundwater and/or surface water (described in Section 3.5 of the companion report):<br>NO GW OR SW: Low Carbonate islands with a maximum width of ≤250 m and Limestone islands with a maximum width of ≤2 km. Note that the Limestone island of Nauru has unlikely potential for fresh groundwater or surface water and is also assigned NO GW OR SW;<br>GW: Low Carbonate islands with a maximum width of >250 m and Limestone islands with a maximum width of >2 km.<br>GW AND SW: All Volcanic, Composite and Complex islands.<br>'Not Assessed' signifies islands with insufficient information to determine the potential for freshwater sources. |
| **Maximum_Elevation** | Double | Numeric | | Estimate of island maximum elevation in metres. Maximum elevation values were acquired from various sources. All Low Carbonate islands (2,529 islands) were assigned an elevation of <5 m based on the physical processes that underpin their formation. Additional island maximum elevation data were obtained from the University of New England (L. Kumar, pers. comm. 2014) for 940 islands in the database based on a compilation of data from a range of sources: literature values, ASTER (Ministry of Economy, Trade and Industry of Japan (METI) & United States National Aeronautics and Space Administration (NASA) 2011) and Google Earth (Google Inc. 2012; based on the Shuttle Radar Topography Mission). For islands without elevation values, maximum elevations (for an additional 1,087 islands) were calculated from the Shuttle Radar Topography Mission (SRTM) 3-arc-second DEM (National Geospatial-Intelligence Agency (NGA) and National Aeronautics and Space Administration (NASA) 2000).<br><br>For SRTM elevation values, relevant 3 second SRTM tiles covering the Pacific region of interest were downloaded from USGS (http://earthexplorer.usgs.gov) throughout March 2013. Tiles were downloaded individually in .bil format, extracted, added to a mosaic dataset, and then combined by exporting to a single raster. All tiles and the combined raster were in WGS84, and not projected. The dataset did not undergo further processing or verification. A number of SRTM pixels (in island areas) were visually identified as having missing or incorrect values (e.g. elevation precision across very low-lying islands). The SRTM elevation data were combined with the island polygons, using the ESRI Zonal Statistics tool, to generate statistics based on the maximum elevation values falling within each of the island polygons. |

| Field Name | Attribute Type | Case | Valid Values | Description and Lineage |
|---|---|---|---|---|
| | | | | The various elevation data sources have differing levels of accuracy. It is assumed that literature values have high vertical accuracy compared to the other data sources; and no error is specified. However, elevation data from the other sources are considered to have an error of between 16 m and 20 m, based on the maximum vertical accuracy of SRTM and ASTER derived data, respectively. Therefore, for all but literature data sources, maximum elevations of ≤5 m are assigned a value of ≤21 m (SRTM derived data) or ≤25 m (ASTER derived data), whilst maximum elevations of >5 m represent maximum values of >21 m (SRTM derived data) or >25 m (ASTER-derived data). Low Carbonate islands have been represented with a maximum elevation of 5 m in the maximum elevation field.<br><br>Values of -9999 signify islands with no elevation data. Due to licencing restrictions, data derived from Google Earth could not be re-distributed. Where this is the case, a value of -9999 has also been used, with Google Earth referenced in the Maximum_Elevation_Reference field. |
| **Maximum_Elevation_Reference** | String, 50 | Mixed | | Source reference of the elevation value in the 'Maximum_Elevation' field. |
| **Maximum_Elevation_Class** | String, 50 | Mixed | <=5, >5, -9999 | Elevation class of the island maximum elevation. Values of -9999 signify islands with no elevation data. Due to licencing restrictions, data derived from Google Earth could not be re-distributed. Where this is the case a value of -9999 has also been used, with Google Earth referenced in the Maximum_Elevation_Reference field. |
| **Rainfall_Sensitivity** | String, 100 | Proper | L, M, MH, H, Not Assessed | Sensitivity of island to changes in rainfall, rated as: Lower; Moderate; Moderate High; or Higher. Rainfall sensitivity was determined from island maximum width and groundwater flow system. Details of the rules applied are in Table 3.3 of the companion report. 'Not Assessed' signifies islands with insufficient information to assign a rainfall sensitivity rating. |
| **System_Adaptability** | String, 100 | Proper | L, M, H, Not Assessed | The adaptability of the groundwater system to reduced rainfall or sea-level rise, rated as: Lower; Moderate; or Higher. System adaptability rating is derived from the principal aquifer, groundwater flow system and groundwater extraction methods. Details of the rules applied are in Table 6.1 of the companion report. 'Not Assessed' signifies islands with insufficient information to assign a system adaptability rating. |
| **Rainfall_Current** | String, 100 | Mixed | <=700, 700 – 1500, >1500 | Current mean annual rainfall (mm/year) for the period 1979-2013. Historical rainfall data was sourced as a NetCDF file (Adler et al. 2003). The NetCDF file was converted to an ESRI grid raster and reclassified into rainfall values of ≤700 mm, 700-1,500 mm and >1,500 mm. Using the ESRI Zonal Statistics tool within ArcMap, the associated rainfall was assigned to each island polygon. If an island polygon overlapped the reclassified boundary, the class which covered more than 50% of the island area was assigned. |

| Field Name | Attribute Type | Case | Valid Values | Description and Lineage |
|---|---|---|---|---|
| **Rainfall_CV_Current** | String, 100 | Mixed | <0.4, >0.4 | Current rainfall Coefficient of Variation (CV) class. CV has been calculated from the GPCP rainfall dataset (1979-2013) sourced as a NetCDF file (Adler et al. 2003). The CV raster was then reclassified into <0.4 and ≥0.4. The associated rainfall CV class was assigned to each island polygon using a spatial join within ArcMap. If an island polygon overlapped the reclassified boundary, the class which covered more than 50% of the island area was assigned. |
| **Rainfall_Exposure_Current** | String, 100 | Mixed | 1,2,3,4,5,6 | Rainfall exposure class of the current mean annual rainfall. The class for each island is either: 1,2,3,4,5 or 6, based on the combination of current mean annual rainfall class and CV class. See Table 3.4 of the companion report for full descriptions of the exposure class. |
| **Lowest_Mean_Rainfall_2050** | Double | Numeric | | Minimum projected island rainfall values (mm/year) for 2050 were calculated from climate models sourced from the CSIRO. The model outputs were percentage change values and were provided as NetCDF files (Grose and Bedin 2013). Global Climate Models (GCM) assessed include: ACCESS-1.3, CNRM-CM5 and GISS-E2R. Models downscaled using Conformal Cubic Atmospheric Model (CCAM) included: ACCESS-1.0, CNRM-CM5, GFDL-CM3, MPI-ESM-LR and NorESM1-M. Minimum rainfall values were extracted for each island using the following method:<br><br>1. All 2050 GCM and CCAM projected rainfall change NetCDF files were imported into ArcMap and exported as ESRI geodatabase raster files.<br>2. Current rainfall grid (Adler et al. 2003) in mm/day was converted to mm/year by the multiplying raster values by 365.<br>3. The 2050 projected change rasters were multiplied by the current rainfall grid to calculate the projected rainfall in mm/year (e.g. if a 20% increase was projected, then the current values were multiplied by 1.2).<br>4. Island polygons were exported within ArcMap as points (except for east New Guinea, PNG). The centre of the island was chosen as the point.<br>5. All GCM and CCAM 2050 rainfall projection models (mm/year) were overlayed on the island points and the islands were attributed with the associated rainfall value at that point (islands were much smaller than the rainfall cells).<br>• East New Guinea, PNG was treated differently due to its large area. Each of the three subregions of east New Guinea was large enough to be covered by multiple rainfall cells. The mean rainfall value of the cells in each subregion was calculated for each model using the ESRI zonal statistics tool.<br>6. All the projected rainfall values attributed to each island were then compiled in a table, and the minimum rainfall value for each island was extracted.<br>7. Islands were assigned a rainfall class based on the extracted projection minimum rainfall value. |

| Field Name | Attribute Type | Case | Valid Values | Description and Lineage |
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| **Lowest_Mean_Rainfall_2050_Reference** | String, 255 | Mixed | | The source rainfall projection model of the Min_Rainfall_2050 rainfall value. |
| **Rainfall_Exposure_2050** | String, 100 | Mixed | <=700, 700 – 1500, >1500 | Rainfall class of the minimum projected rainfall for 2050. The class for each island is either: <=700mm, 700-1,500mm or >1,500mm. |
| **Lowest_Mean_Rainfall_2085** | | | | Minimum projected island rainfall values (mm/year) for 2085 were calculated from climate models sourced from the CSIRO. The model outputs were percentage change values and were provided as NetCDF files (Grose and Bedin 2013). Climate Models (GCM) assessed include: ACCESS-1.3, CNRM-CM5 and GISS-E2R. Models downscaled using Conformal Cubic Atmospheric Model (CCAM) included: ACCESS-1.0, CNRM-CM5, GFDL-CM3, MPI-ESM-LR and NorESM1-M. Minimum rainfall values were extracted for each island using the method described for the 'Rainfall_Exposure_2050' attribute. |
| **Lowest_Mean_Rainfall_2085_Reference** | | | | The source rainfall projection model of the Min_Rainfall_2085 value. |
| **Rainfall_Exposure_2085** | String, 100 | Mixed | <=700, 700 – 1500, >1500 | Rainfall class of the minimum projected rainfall in 2085. The class for each island is either: <=700mm, 700-1,500mm or >1,500mm. |
| **Rainfall_Potential_Impact_Current** | String, 100 | Capitals | L, ML, M, MH, H, Not Assessed | Potential impact of current rainfall rated as: Lower; Moderate Low; Moderate; Moderate High; or Higher for each island. Dependent on the island sensitivity to rainfall change, and the current mean annual rainfall exposure class. Python scripting (arcpy) for use in ArcMap was developed to perform the current potential impact analysis based on the method described in Table 5.1 of the companion report. Results of the script processing were then joined to the islands database using the UniqueID fields. 'Not Assessed' signifies islands with insufficient information to assign a potential impact rating. |
| **Rainfall_Potential_Impact_2050** | String, 100 | Capitals | L, ML, M, MH, H, Not Assessed | Potential impact of minimum projected rainfall in 2050 rated as: Lower; Moderate Low; Moderate; Moderate High; or Higher for each island. Dependent on the island sensitivity to rainfall change, and the projected rainfall exposure class 2050. Python scripting (arcpy) for use in ArcMap was developed to perform the potential impact analysis based on the method described in Table 5.1 of the companion report. Results of the script processing were then joined to the islands database using the UniqueID fields. 'Not Assessed' signifies islands with insufficient information to assign a rating. |
| **Rainfall_Potential_Impact_2085** | String, 100 | Capitals | L, ML, M, MH, H, Not Assessed | Potential impact of minimum projected rainfall in 2085 rated as: Lower; Moderate Low; Moderate; Moderate High; or Higher for each island. Dependent on the island sensitivity to rainfall change, and the projected rainfall exposure class 2085. Python scripting (arcpy) for use in ArcMap was developed to perform the potential impact analysis based on the method described in Table 5.1 of the companion report. Results of the script processing were then joined to the islands database using the UniqueID fields. 'Not Assessed' signifies islands with insufficient information to assign a rating. |

| Field Name | Attribute Type | Case | Valid Values | Description and Lineage |
|---|---|---|---|---|
| **Rainfall_Vulnerability_Current** | String, 100 | Capitals | L, ML, M, MH, H, Not Assessed | Island potential vulnerability to current mean annual rainfall, based on: island type, groundwater flow system, potential impact of current rainfall and system adaptability. Potential vulnerability rated as: Lower; Moderate Low; Moderate; Moderate High; or Higher. Python scripting (arcpy) for use in ArcMap was developed to perform the vulnerability analysis based on the method described in Table 7.2 of the companion report. Results of the script processing were then joined to the islands database using the UniqueID fields. 'Not Assessed' signifies islands with insufficient information to assign a rating. |
| **Rainfall_Vulnerability_2050** | String, 100 | Capitals | L, ML, M, MH, H, Not Assessed | Island potential vulnerability to a reduction in mean rainfall in 2050, based on: island type, groundwater flow system, potential impact of reduced rainfall and system adaptability. Potential vulnerability rated as: Lower; Moderate Low; Moderate; Moderate High; or Higher. Python scripting (arcpy) for use in ArcMap was developed to perform the vulnerability analysis based on the method described in Table 7.2 of the companion report. Results of the script processing were then joined to the islands database using the UniqueID fields. 'Not Assessed' signifies islands with insufficient information to assign a rating. |
| **Rainfall_Vulnerability_2085** | String, 100 | Capitals | L, ML, M, MH, H, Not Assessed | Island potential vulnerability to a reduction in mean rainfall in 2085, based on: island type, groundwater flow system, potential impact of reduced rainfall and system adaptability. Potential vulnerability rated as: Lower; Moderate Low; Moderate; Moderate High; or Higher. Python scripting (arcpy) for use in ArcMap was developed to perform the vulnerability analysis based on the method described in Table 7.2 of the companion report. Results of the script processing were then joined to the islands database using the UniqueID fields. 'Not Assessed' signifies islands with insufficient information to assign a rating. |
| **Sea_level_Sensitivity** | String, 100 | Capitals | L, ML, M, MH, H, Not Assessed | Sensitivity of island to change in sea level in 2050 rated as: Lower; Moderate Low; Moderate; Moderate High; or Higher. Sea-level sensitivity was determined from island maximum width, groundwater flow system and elevation class. Details of the rules applied are in Table 3.6 of the companion report. 'Not Assessed' signifies islands with insufficient information to assign a sea-level sensitivity rating. |
| **Sea_level_Exposure_2050** | String, 50 | Mixed | <=0.25, >0.25, <0.4, No sea-level data available | Island sea-level rise class of projected mean sea-level rise for 2050. In 2050, the class for each island is either: ≤0.25 m, >0.25 m or <0.4 m, depending on the island type and maximum width (refer to Table 5.2 in the companion report). 'No sea-level data available' signifies islands with no data. The aggregated sea-level model for 2050 under an RCP8.5 emissions scenario (middle-mean variable) was sourced as a NetCDF file (CSIRO unpub. 2013). The data was processed as follows to derive the sea-level exposure class of each island:<br>1. The NetCDF file was opened in ArcMAP, the variable properties set to display the 'mid-mean' attribute, then exported to an Arc file geodatabase raster. |

| Field Name | Attribute Type | Case | Valid Values | Description and Lineage |
|---|---|---|---|---|
| | | | | 2. This data was then projected in ArcMap into WGS84 (original netDCF projection) and grid cell size of 1.5˚.<br>3. The sea-level raster was then reclassified into the sea-level exposure classes (≤0.25 m, >0.25 m or <0.4 m).<br>4. The islands were then assigned the associated sea-level exposure class value using the ESRI Spatial join tool within ArcMap.<br>5. Islands which crossed over two sea-level classes were assigned the class that the majority of the island fell in (>50%). |
| **Sea_level_Exposure_2085** | String, 50 | Mixed | >=0.4, <=0.58, >.58, No sea-level data available | Island sea level rise class of projected rise in relative mean sea level for 2085. In 2085, the class for each island is either: ≤0.58m, >0.58m or ≥0.4, depending on the island type and maximum width (refer to Table 5.2 in the companion report). 'No sea-level data available' signifies islands with no data. The aggregated sea-level model for 2085 under an RCP8.5 emissions scenarios (middle mean variable) was sourced as a NetCDF file (CSIRO unpub. 2013). The data was processed following the methods described for the 'Sea_Level_Exposure_2050' attribute. |
| **Sea_level_Potential_Impact_2050** | String, 100 | Capitals | L, ML, M, MH, Not Assessed | Potential impact of RCP8.5 projected sea-level rise in 2050 rated as Lower; Moderate Low; Moderate; Moderate High; or Higher. Dependent on the island sensitivity to sea-level rise, and the projected sea-level rise (exposure). See Table 5.2 of the companion report for the rules used to develop potential impact ratings. 'Not Assessed' signifies islands with insufficient information to assign a rating. |
| **Sea_level_Potential_Impact_2085** | String, 100 | Capitals | L, ML, M, H, Not Assessed | Potential impact of RCP8.5 projected sea-level rise in 2085 rated as: Lower; Moderate Low; Moderate; Moderate High; or Higher. Dependent on the island sensitivity to sea-level change, and the projected sea-level rise (exposure). See Table 5.2 of the companion report for the rules used to develop potential impact ratings. 'Not Assessed' signifies islands with insufficient information to assign a rating. |
| **Sea_level_Vulnerability_2050** | String, 100 | Capitals | L, ML, M, MH, Not Assessed | Island potential vulnerability to projected sea-level rise in 2050, based on potential impact of sea-level rise, and system adaptability. Vulnerability rated as: Lower; Moderate Low; Moderate; Moderate High; or Higher. See Table 7.5 of the companion report for rules used to develop potential vulnerability ratings. 'Not Assessed' signifies islands with insufficient information to assign a rating. |
| **Sea_level_Vulnerability_2085** | String, 100 | Capitals | L, ML, M, H, Not Assessed | Island potential vulnerability to projected sea-level rise in 2085, based on potential impact of sea-level rise, and system adaptability. Vulnerability rated as: Lower; Moderate Low; Moderate; Moderate High; or Higher. See Table 7.5 of the companion report for rules used to develop potential vulnerability ratings. 'Not Assessed' signifies islands with insufficient information to assign a rating. |

| Field Name | Attribute Type | Case | Valid Values | Description and Lineage |
|---|---|---|---|---|
| **Population_Density_2010** | Double | Numeric | | Island-scale population density (people/km$^2$) estimate for 2010. The population density values were generated from country census Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI) population data (AIR Worldwide 2011). PCRAFI data was initially supplied as part of a larger data package by country. The 2010 population projection data were extracted and compiled for the countries included in the study. The method to assign population densities to individual islands assumed an equal distribution of people within each PCRAFI population region.<br><br>The population density of each island was calculated as the PCRAFI population count divided by the land area in square kilometres (as calculated from the Pacific Islands database polygons). In the majority of cases the PCRAFI population areas did not cover a single island, but either covered multiple islands, a section of an island, or a combination of both. As such, the method to calculate population density varied slightly for each of these scenarios. Details of the method applied are shown in Appendix C.5 of the companion report. A variation of the method was used to calculate the population density for the three subregions of the main island of PNG (east New Guinea). All PCRAFI population areas that had their centroid within a subregion were selected. The total population of a subregion was then divided by the area of the subregion to derive a population density.<br><br>PCRAFI population data was not available for Tokelau; however, the same method was applied to the islands in Tokelau using SPC country scale 2010 projected population data (SPC, pers. comm. 2011). The SPC country value was distributed between regions using the relative distribution of population from 2011 census data (Tokelau National Statistics Office 2011). |
| **Population_Density_2050** | Double | Numeric | | Island-scale population density (people/km$^2$) estimate for 2050. Densities were calculated by applying a scaling factor to the 2010 population densities (Population_Density_2010), based on 2050 projected population data sourced for each country (SPC, pers. comm. 2011). Note that for some countries the projected population was the same between projection years. Values of -9999 signify that population data was not available. |
| **Population_Density_2100** | Double | Numeric | | Island-scale population density (people/km$^2$) estimate for 2100. Densities were calculated by applying a scaling factor to the 2010 population densities (Population_Density_2010), based on 2100 projected population data sourced for each country (SPC, pers. comm. 2011). Note that for some countries the projected population was the same between projection years. Values of -9999 signify that population data was not available. |
| **Population_Reference** | String, 50 | Mixed | | Data source reference of the 2010 population projection values used to calculate the population density for 2010 (Population_Density_2010). |

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## Personal Communications

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