Model Documentation

Total	Count	Including Array Elements
Variables	302	302
Modules	9	
Stocks	11	11
Flows	26	26
Converters	265	265
Constants	93	93
Equations	198	198
Graphicals	45	45
Macro Variables	5	

	Equation	Properties	Units	Documentation	Annotation
Top-Level Model:					
Climate_Impacts:					
degree_of_warming	PROJECTED_TEMPERATURE- 27.77		Degrees C	The degree of warming is the projected temperature minus the average historical temperature between 1990-2022 (27.77deg c).	
EFFECT_OF_SEA_LEVEL_RISE_ON_LAND_LOSS	GRAPH(sea_level_rise) Points: (0.000, 0.000), (0.0612244897959, 0.0005165), (0.122448979592, 0.001171), (0.183673469388, 0.002004), (0.244897959184, 0.00307), (0.30612244898, 0.004438), (0.367346938776, 0.006198), (0.428571428571, 0.008466), (0.489795918367, 0.01139), (0.551020408163, 0.01516), (0.612244897959, 0.02001), (0.673469387755, 0.02625), (0.734693877551, 0.03425), (0.795918367347, 0.04447), (0.857142857143, 0.05746), (0.918367346939, 0.07386), (0.979591836735, 0.09439), (1.04081632653, 0.1198), (1.10204081633, 0.1509), (1.16326530612, 0.1883), (1.22448979592, 0.2323), (1.28571428571, 0.283), (1.34693877551, 0.3399), (1.40816326531, 0.4017), (1.4693877551, 0.4669), (1.5306122449, 0.5331), (1.59183673469, 0.5983), (1.65306122449, 0.6601), (1.71428571429, 0.717), (1.77551020408, 0.7677), (1.83673469388, 0.8117), (1.89795918367, 0.8491), (1.95918367347, 0.8802), (2.02040816327, 0.9056), (2.08163265306, 0.9261), (2.14285714286, 0.9425), (2.20408163265, 0.9555), (2.26530612245, 0.9658), (2.32653061224, 0.9738), (2.38775510204, 0.980), (2.44897959184, 0.9848), (2.51020408163, 0.9886), (2.57142857143, 0.9915), (2.63265306122, 0.9938), (2.69387755102, 0.9956), (2.75510204082, 0.9969), (2.81632653061, 0.998), (2.87755102041, 0.9988), (2.9387755102, 0.9995), (3.000, 1.000)		1/year	Relationship is estimated from researcher judgement. Highest elevation in Tarawa is 3m.	
function_for_effect_of_sea_level_rise_on_land_loss	MAX_FUNCTION_VALUE/(1+ EXP(-LOGISTIC_GROWTH_RATE*(sea_level_rise-FUNCTION_MIDPOINT)))		1/year	This logistic equation represents an S-shaped curve where parameters can be calibrated. f(x) = L / (1+e ^(-k (x - x_0)) where: L = curve's max value k = logistic growth rate x = sea level rise x_0 = sigmoid midpoint	
FUNCTION_MIDPOINT	1.5		meters	As the primary land analysis is based in South Tarawa, the highest elevation (3m) was used as the maximum x value. The midpoint value was thus 1.5m.	

HISTORIC_RAINFALL	GRAPH(TIME) Points: (1990.00, 1861.59), (1991.00, 1876.01), (1992.00, 1746.04), (1993.00, 1851.57), (1994.00, 1458.13), (1995.00, 1047.48), (1996.00, 840.4), (1997.00, 1536.56), (1998.00, 1276.17), (1999.00, 1303.29), (2000.00, 1237.89), (2001.00, 1436.13), (2002.00, 1425.16), (2003.00, 1424.61), (2004.00, 1424.26), (2005.00, 1423.99), (2006.00, 1423.91), (2007.00, 1423.07), (2008.00, 1421.25), (2009.00, 1424.72), (2010.00, 1423.85), (2011.00, 1424.26), (2012.00, 1424.26), (2013.00, 1424.26), (2014.00, 1424.26), (2015.00, 1424.26), (2016.00, 1424.26), (2017.00, 1424.26), (2018.00, 1424.26), (2019.00, 1421.96), (2020.00, 1388.57), (2021.00, 1393.91), (2022.00, 1238.1)		mm / year	Historical rainfall data from World Bank Climate Knowledge Portal. Data downloaded from graphic, 'Observed Annual Precipitation of Kiribati for 1901-2022'. The annual mean rainfall per year was used. Note: The same value was reported from 2011-2018. This data was used in the absence of other data to validate. Source: https://climateknowledgeportal.worldbank.org/country/kiribati/climate-data-historical	
HISTORIC_TEMPERATURE	GRAPH(TIME) Points: (1990.00, 27.750), (1991.00, 27.720), (1992.00, 27.710), (1993.00, 27.670), (1994.00, 27.740), (1995.00, 27.790), (1996.00, 27.750), (1997.00, 27.750), (1998.00, 27.790), (1999.00, 27.650), (2000.00, 27.720), (2001.00, 27.770), (2002.00, 27.790), (2003.00, 27.790), (2004.00, 27.800), (2005.00, 27.800), (2006.00, 27.780), (2007.00, 27.760), (2008.00, 27.730), (2009.00, 27.750), (2010.00, 27.690), (2011.00, 27.710), (2012.00, 27.790), (2013.00, 27.780), (2014.00, 27.780), (2015.00, 27.800), (2016.00, 27.810), (2017.00, 27.800), (2018.00, 27.780), (2019.00, 27.870), (2020.00, 27.920), (2021.00, 27.890), (2022.00, 27.770)		Degrees C	Data for historic temperature is from the World Bank Climate Knowledge Portal (Table: 'Observed Annual Average Mean Surface Air Temperature of Kiribati for 1901-2022'). Source: https://climateknowledgeportal.worldbank.org/country/kiribati/climate-data-historical	
LOGISTIC_GROWTH_RATE	5		1/meters	Value was determined through calibration to historic land area data.	
MAX_FUNCTION_VALUE	1		1 / year	A maximum function value of 1 indicates 100% inundation.	
PROJECTED_RAINFALL	IF TIME < 2023 THEN HISTORIC_RAINFALL ELSE (IF SSP119_SWITCH = 1 THEN SSP119_RAINFALL_PROJECTIONS ELSE (IF SSP126_SWITCH = 1 THEN SSP126_RAINFALL_PROJECTIONS ELSE (IF SSP245_SWITCH = 1 THEN SSP245_RAINFALL_PROJECTIONS ELSE (IF SSP370_SWITCH = 1 THEN SSP370_RAINFALL_PROJECTIONS ELSE (IF SSP585_SWITCH = 1 THEN SSP585_RAINFALL_PROJECTIONS ELSE HISTORIC_RAINFALL)))))		mm / year	Historic data was available and used up to 2023, after which projected rainfall data was used for each respective SSP.	
PROJECTED_TEMPERATURE	IF TIME < 2022 THEN HISTORIC_TEMPERATURE ELSE (IF SSP119_SWITCH = 1 THEN SSP119_TEMPERATURE_PROJECTIONS ELSE (IF SSP126_SWITCH = 1 THEN SSP126_TEMPERATURE_PROJECTIONS ELSE (IF SSP245_SWITCH = 1 THEN SSP245_TEMPERATURE_PROJECTIONS ELSE (IF SSP370_SWITCH = 1 THEN SSP370_TEMPERATURE_PROJECTIONS ELSE (IF SSP585_SWITCH = 1 THEN SSP585_TEMPERATURE_PROJECTIONS ELSE HISTORIC_TEMPERATURE)))))		Degrees C	Historic data was available and used up to 2022, after which projected rainfall data was used for each respective SSP. Note: there is a discrepancy between historic data in 2022 (27.77deg C) and the projected degrees of warming in 2022 for the SSPs where the projected temperature is lower than observed. As such, there is a dip in the trend at this point.	
sea_level_rise	IF TIME < 2020 THEN RAMP(0.0017, 1990, 2020) ELSE (IF SSP119_SWITCH = 1 THEN SSP119_SLR_PROJECTIONS ELSE (IF SSP126_SWITCH = 1 THEN SSP126_SLR_PROJECTIONS ELSE (IF SSP126_SWITCH = 1 THEN SSP126_SLR_PROJECTIONS ELSE (IF SSP245_SWITCH = 1 THEN SSP245_SLR_PROJECTIONS ELSE (IF SSP370_SWITCH = 1 THEN SSP370_SLR_PROJECTIONS ELSE (IF SSP585_SWITCH = 1 THEN SSP585_SLR_PROJECTIONS ELSE 0.05))))))		meters	The average sea level from 1995-2014 (1.6535m) in Kiribati was used as the baseline. The ramp from 1990-2020 was calculated as the slope from baseline historic level to the beginning of the projections in 2020 (~1.70m). After 2020, IPCC data was used for each respective SSP.	

SSP119_RAINFALL_PROJECTIONS	GRAPH(TIME) Points: (2023.00, 1167.33), (2024.00, 1220.17), (2025.00, 1233.9), (2026.00, 1245), (2027.00, 1280.07), (2028.00, 1301.72), (2029.00, 1215.78), (2030.00, 1166.27), (2031.00, 1372.81), (2032.00, 1211.7), (2033.00, 1182.72), (2034.00, 1246.4), (2035.00, 1281.81), (2036.00, 1247.51), (2037.00, 1373.13), (2038.00, 1301.07), (2039.00, 1256.84), (2040.00, 1327.65), (2041.00, 1284.92), (2042.00, 1299.49), (2043.00, 1307.63), (2044.00, 1276.37), (2045.00, 1259.89), (2046.00, 1412.38), (2047.00, 1268.71), (2048.00, 1351.38), (2049.00, 1422.8), (2050.00, 1329.69), (2051.00, 1311.53), (2052.00, 1294.12), (2053.00, 1314.64), (2054.00, 1308.11), (2055.00, 1361.28), (2056.00, 1385.51), (2057.00, 1367.48), (2058.00, 1331.65), (2059.00, 1343.04), (2060.00, 1392.39), (2061.00, 1387), (2062.00, 1395.24), (2063.00, 1377.5), (2064.00, 1341.15), (2065.00, 1318.92), (2066.00, 1466.13), (2067.00, 1341.92), (2068.00, 1350.75), (2069.00, 1361.45), (2070.00, 1329.98), (2071.00, 1320.11), (2072.00, 1346.68), (2073.00, 1439.24), (2074.00, 1355.44), (2075.00, 1343.56), (2076.00, 1394.49), (2077.00, 1333.43), (2078.00, 1411.36), (2079.00, 1356.94), (2080.00, 1310.75), (2081.00, 1354.38), (2082.00, 1358.96), (2083.00, 1358.63), (2084.00, 1350.53), (2085.00, 1383.17), (2086.00, 1383.76), (2087.00, 1356.83), (2088.00, 1375.95), (2089.00, 1372.54), (2090.00, 1332.2), (2091.00, 1361.32), (2092.00, 1354.06), (2093.00, 1356.43), (2094.00, 1380.08), (2095.00, 1364.32), (2096.00, 1356.94), (2097.00, 1366.57), (2098.00, 1434.37), (2099.00, 1383.03), (2100.00, 1423.84)		mm / year	Data from Climate Change Knowledge Portal, 'Projected Precipitation'. https://climateknowledgeportal.worldbank.org/country/kiribati/cmip5	
SSP119_SLR_PROJECTIONS	GRAPH(TIME) Points: (2020.00, 0.054), (2030.00, 0.100), (2040.00, 0.138), (2050.00, 0.193), (2060.00, 0.230), (2070.00, 0.293), (2080.00, 0.342), (2090.00, 0.404), (2100.00, 0.455)		meters	Projections are based on 'IPCC AR6 Sea-Level Rise Projections' specifically for Betio, South Tarawa, Kiribati (psmsl_id 1804). Median values for each SSP projection was used. Projection values are relative to a 1995-2014 baseline. This baseline was calculated to be 1.6535m from the Australian Government Bureau of Meteorology's historical sea level data.	
SSP119_SWITCH	0		Dimensionless	Switch turns on scenario for SSP 1-1.9.	

SSP119_TEMPERATURE_PROJECTIONS	GRAPH(TIME) Points: (2014.00, 26.890), (2015.00, 27.010), (2016.00, 27.060), (2017.00, 27.120), (2018.00, 27.140), (2019.00, 27.110), (2020.00, 27.110), (2021.00, 27.180), (2022.00, 27.170), (2023.00, 27.220), (2024.00, 27.220), (2025.00, 27.230), (2026.00, 27.260), (2027.00, 27.330), (2028.00, 27.370), (2029.00, 27.240), (2030.00, 27.350), (2031.00, 27.470), (2032.00, 27.320), (2033.00, 27.310), (2034.00, 27.340), (2035.00, 27.380), (2036.00, 27.420), (2037.00, 27.490), (2038.00, 27.510), (2039.00, 27.440), (2040.00, 27.450), (2041.00, 27.480), (2042.00, 27.480), (2043.00, 27.490), (2044.00, 27.460), (2045.00, 27.520), (2046.00, 27.580), (2047.00, 27.500), (2048.00, 27.590), (2049.00, 27.570), (2050.00, 27.520), (2051.00, 27.490), (2052.00, 27.470), (2053.00, 27.500), (2054.00, 27.470), (2055.00, 27.510), (2056.00, 27.540), (2057.00, 27.550), (2058.00, 27.540), (2059.00, 27.520), (2060.00, 27.530), (2061.00, 27.510), (2062.00, 27.510), (2063.00, 27.470), (2064.00, 27.470), (2065.00, 27.470), (2066.00, 27.500), (2067.00, 27.450), (2068.00, 27.470), (2069.00, 27.480), (2070.00, 27.430), (2071.00, 27.450), (2072.00, 27.450), (2073.00, 27.440), (2074.00, 27.440), (2075.00, 27.400), (2076.00, 27.400), (2077.00, 27.390), (2078.00, 27.380), (2079.00, 27.370), (2080.00, 27.360), (2081.00, 27.390), (2082.00, 27.400), (2083.00, 27.380), (2084.00, 27.350), (2085.00, 27.380), (2086.00, 27.360), (2087.00, 27.350), (2088.00, 27.350), (2089.00, 27.340), (2090.00, 27.340), (2091.00, 27.350), (2092.00, 27.350), (2093.00, 27.340), (2094.00, 27.410), (2095.00, 27.340), (2096.00, 27.380), (2097.00, 27.380), (2098.00, 27.430), (2099.00, 27.450), (2100.00, 27.440)		Degrees C	Data for projected temperature is from the World Bank Climate Knowledge Portal (Table: 'Projected Average Mean Surface Air Temperature Kiribati; (Ref. Period:1995-2014), Multi-Model Ensemble'). Source: https://climateknowledgeportal.worldbank.org/country/kiribati/climate-data-projections	
SSP126_RAINFALL_PROJECTIONS	GRAPH(TIME) Points: (2023.00, 1260.31), (2024.00, 1399.4), (2025.00, 1196.26), (2026.00, 1154.97), (2027.00, 1187.94), (2028.00, 1405.49), (2029.00, 1304.56), (2030.00, 1264.23), (2031.00, 1427.6), (2032.00, 1155.48), (2033.00, 1319.07), (2034.00, 1418.04), (2035.00, 1196.03), (2036.00, 1182.95), (2037.00, 1336.78), (2038.00, 1263.27), (2039.00, 1243.77), (2040.00, 1226.55), (2041.00, 1335.3), (2042.00, 1340.87), (2043.00, 1363.93), (2044.00, 1272.48), (2045.00, 1269.65), (2046.00, 1600.82), (2047.00, 1313.62), (2048.00, 1182.41), (2049.00, 1373.21), (2050.00, 1589.61), (2051.00, 1402.61), (2052.00, 1101.57), (2053.00, 1265.18), (2054.00, 1325), (2055.00, 1487.43), (2056.00, 1557.23), (2057.00, 1463.88), (2058.00, 1256.94), (2059.00, 1270.18), (2060.00, 1302.74), (2061.00, 1367.56), (2062.00, 1393.32), (2063.00, 1449.48), (2064.00, 1394.45), (2065.00, 1112.87), (2066.00, 1784.74), (2067.00, 1507.69), (2068.00, 1347.37), (2069.00, 1271.56), (2070.00, 1302.84), (2071.00, 1223.27), (2072.00, 1409.27), (2073.00, 1601.04), (2074.00, 1304.19), (2075.00, 1337.9), (2076.00, 1438.73), (2077.00, 1364.49), (2078.00, 1833.67), (2079.00, 1392.75), (2080.00, 1168.29), (2081.00, 1416.76), (2082.00, 1558.89), (2083.00, 1294.41), (2084.00, 1311), (2085.00, 1466.28), (2086.00, 1591.07), (2087.00, 1430.22), (2088.00, 1302.08), (2089.00, 1378.55), (2090.00, 1303.01), (2091.00, 1511.85), (2092.00, 1353.85), (2093.00, 1312.62), (2094.00, 1151.67), (2095.00, 1308.08), (2096.00, 1230.38), (2097.00, 1254.07), (2098.00, 1504.77), (2099.00, 1457.32), (2100.00, 1464.1)		mm / year	Data from Climate Change Knowledge Portal, 'Projected Precipitation'. https://climateknowledgeportal.worldbank.org/country/kiribati/cmip5	

SSP126_SLR_PROJECTIONS	GRAPH(TIME) Points: (2020.00, 0.056), (2030.00, 0.099), (2040.00, 0.147), (2050.00, 0.210), (2060.00, 0.259), (2070.00, 0.330), (2080.00, 0.391), (2090.00, 0.449), (2100.00, 0.510)		meters	Projections are based on 'IPCC AR6 Sea-Level Rise Projections' specifically for Betio, South Tarawa, Kiribati (psmsl_id 1804). Median values for each SSP projection was used. Projection values are relative to a 1995-2014 baseline. This baseline was calculated to be 1.6535m from the Australian Government Bureau of Meteorology's historical sea level data.	
SSP126_SWITCH	0		Dimensionless	Switch turns on scenario for SSP 1-2.6.	
SSP126_TEMPERATURE_PROJECTIONS	GRAPH(TIME) Points: (2014.00, 26.890), (2015.00, 27.080), (2016.00, 27.110), (2017.00, 27.090), (2018.00, 27.060), (2019.00, 27.350), (2020.00, 27.310), (2021.00, 27.180), (2022.00, 27.070), (2023.00, 27.400), (2024.00, 27.370), (2025.00, 27.190), (2026.00, 27.200), (2027.00, 27.300), (2028.00, 27.410), (2029.00, 27.350), (2030.00, 27.510), (2031.00, 27.580), (2032.00, 27.340), (2033.00, 27.530), (2034.00, 27.450), (2035.00, 27.440), (2036.00, 27.590), (2037.00, 27.560), (2038.00, 27.550), (2039.00, 27.510), (2040.00, 27.380), (2041.00, 27.670), (2042.00, 27.720), (2043.00, 27.610), (2044.00, 27.530), (2045.00, 27.570), (2046.00, 27.870), (2047.00, 27.660), (2048.00, 27.700), (2049.00, 27.820), (2050.00, 27.830), (2051.00, 27.610), (2052.00, 27.520), (2053.00, 27.790), (2054.00, 27.660), (2055.00, 27.760), (2056.00, 27.840), (2057.00, 27.770), (2058.00, 27.740), (2059.00, 27.720), (2060.00, 27.700), (2061.00, 27.760), (2062.00, 27.920), (2063.00, 27.830), (2064.00, 27.730), (2065.00, 27.770), (2066.00, 28.000), (2067.00, 27.770), (2068.00, 27.800), (2069.00, 27.980), (2070.00, 27.730), (2071.00, 27.750), (2072.00, 27.760), (2073.00, 27.900), (2074.00, 27.890), (2075.00, 27.890), (2076.00, 27.830), (2077.00, 27.850), (2078.00, 27.840), (2079.00, 27.790), (2080.00, 27.760), (2081.00, 27.970), (2082.00, 27.940), (2083.00, 27.800), (2084.00, 27.810), (2085.00, 27.790), (2086.00, 27.830), (2087.00, 27.710), (2088.00, 27.690), (2089.00, 27.710), (2090.00, 27.720), (2091.00, 27.850), (2092.00, 27.730), (2093.00, 27.670), (2094.00, 27.860), (2095.00, 27.650), (2096.00, 27.660), (2097.00, 27.630), (2098.00, 27.810), (2099.00, 27.830), (2100.00, 27.710)		Degrees C	Data for projected temperature is from the World Bank Climate Knowledge Portal (Table: 'Projected Average Mean Surface Air Temperature Kiribati; (Ref. Period:1995-2014), Multi-Model Ensemble'). Source: https://climateknowledgeportal.worldbank.org/country/kiribati/climate-data-projections	

SSP245_RAINFALL_PROJECTIONS	GRAPH(TIME) Points: (2023.00, 1092.68), (2024.00, 1272.56), (2025.00, 1257.53), (2026.00, 1300.68), (2027.00, 1101.41), (2028.00, 1178.82), (2029.00, 1403.35), (2030.00, 1026.44), (2031.00, 1387.39), (2032.00, 1332.67), (2033.00, 1035.28), (2034.00, 1307.76), (2035.00, 1282.08), (2036.00, 1084.69), (2037.00, 1550.15), (2038.00, 1327.61), (2039.00, 1112.76), (2040.00, 1419.58), (2041.00, 1409.22), (2042.00, 1262.12), (2043.00, 1174.72), (2044.00, 1148.96), (2045.00, 1183.4), (2046.00, 1462.39), (2047.00, 1155.72), (2048.00, 1525.48), (2049.00, 1418.44), (2050.00, 1240.55), (2051.00, 1294.82), (2052.00, 1342.03), (2053.00, 1262.26), (2054.00, 1328.9), (2055.00, 1472.07), (2056.00, 1223.78), (2057.00, 1288.79), (2058.00, 1389.2), (2059.00, 1615.82), (2060.00, 1560.91), (2061.00, 1364.62), (2062.00, 1541.98), (2063.00, 1470.3), (2064.00, 1311.35), (2065.00, 1538.01), (2066.00, 1649.34), (2067.00, 1146.92), (2068.00, 1611.08), (2069.00, 1341.78), (2070.00, 1242.15), (2071.00, 1411.49), (2072.00, 1552.06), (2073.00, 1689.13), (2074.00, 1291.28), (2075.00, 1317.84), (2076.00, 1776.5), (2077.00, 1574.7), (2078.00, 1375.73), (2079.00, 1270.85), (2080.00, 1375.76), (2081.00, 1557.94), (2082.00, 1405.64), (2083.00, 1620.45), (2084.00, 1689.21), (2085.00, 1682.4), (2086.00, 1553.91), (2087.00, 1480.84), (2088.00, 1701.92), (2089.00, 1437.21), (2090.00, 1452.37), (2091.00, 1439.49), (2092.00, 1619.99), (2093.00, 1444.08), (2094.00, 1579.43), (2095.00, 1677.48), (2096.00, 1406.68), (2097.00, 1394.27), (2098.00, 1719.36), (2099.00, 1345.17), (2100.00, 1672.54)		mm / year	Data from Climate Change Knowledge Portal, 'Projected Precipitation'. https://climateknowledgeportal.worldbank.org/country/kiribati/cmip5	
SSP245_SLR_PROJECTIONS	GRAPH(TIME) Points: (2020.00, 0.052), (2030.00, 0.099), (2040.00, 0.152), (2050.00, 0.226), (2060.00, 0.290), (2070.00, 0.367), (2080.00, 0.452), (2090.00, 0.537), (2100.00, 0.628)		meters	Projections are based on 'IPCC AR6 Sea-Level Rise Projections' specifically for Betio, South Tarawa, Kiribati (psmsl_id 1804). Median values for each SSP projection was used. Projection values are relative to a 1995-2014 baseline. This baseline was calculated to be 1.6535m from the Australian Government Bureau of Meteorology's historical sea level data.	
SSP245_SWITCH	0		Dimensionless	Switch turns on scenario for SSP 2-4.5.	
SSP245_TEMPERATURE_PROJECTIONS	GRAPH(TIME) Points: (2014.00, 26.890), (2015.00, 26.920), (2016.00, 26.960), (2017.00, 27.050), (2018.00, 27.010), (2019.00, 26.900), (2020.00, 27.020), (2021.00, 27.270), (2022.00, 27.210), (2023.00, 27.180), (2024.00, 27.300), (2025.00, 27.230), (2026.00, 27.260), (2027.00, 27.270), (2028.00, 27.420), (2029.00, 27.340), (2030.00, 27.480), (2031.00, 27.660), (2032.00, 27.450), (2033.00, 27.300), (2034.00, 27.410), (2035.00, 27.470), (2036.00, 27.470), (2037.00, 27.730), (2038.00, 27.740), (2039.00, 27.520), (2040.00, 27.680), (2041.00, 27.690), (2042.00, 27.550), (2043.00, 27.650), (2044.00, 27.580), (2045.00, 27.790), (2046.00, 27.900), (2047.00, 27.740), (2048.00, 27.950), (2049.00, 27.940), (2050.00, 27.870), (2051.00, 27.900), (2052.00, 27.930), (2053.00, 27.820), (2054.00, 27.910), (2055.00, 27.900), (2056.00, 28.040), (2057.00, 28.070), (2058.00, 28.090), (2059.00, 28.210), (2060.00, 28.250), (2061.00, 27.990), (2062.00, 28.020), (2063.00, 28.070), (2064.00, 28.070), (2065.00, 28.200), (2066.00, 28.050), (2067.00, 27.990), (2068.00, 28.270), (2069.00, 28.160), (2070.00, 28.200), (2071.00, 28.330), (2072.00, 28.400), (2073.00, 28.320), (2074.00, 28.200), (2075.00, 28.290), (2076.00, 28.430), (2077.00, 28.350), (2078.00, 28.300), (2079.00, 28.450), (2080.00, 28.300), (2081.00, 28.390), (2082.00, 28.420), (2083.00, 28.500), (2084.00, 28.570), (2085.00, 28.650), (2086.00, 28.470), (2087.00, 28.560), (2088.00, 28.500), (2089.00, 28.470), (2090.00, 28.580), (2091.00, 28.630), (2092.00, 28.640), (2093.00, 28.420), (2094.00, 28.610), (2095.00, 28.560), (2096.00, 28.500), (2097.00, 28.550), (2098.00, 28.550), (2099.00, 28.610), (2100.00, 28.690)		Degrees C	Data for projected temperature is from the World Bank Climate Knowledge Portal (Table: 'Projected Average Mean Surface Air Temperature Kiribati; (Ref. Period:1995-2014), Multi-Model Ensemble'). Source: https://climateknowledgeportal.worldbank.org/country/kiribati/climate-data-projections	

SSP370_RAINFALL_PROJECTIONS	GRAPH(TIME) Points: (2023.00, 1192.09), (2024.00, 1024.71), (2025.00, 1275.12), (2026.00, 1316.71), (2027.00, 1595.64), (2028.00, 1419.85), (2029.00, 945.93), (2030.00, 1039.44), (2031.00, 1281.69), (2032.00, 1219.7), (2033.00, 1167.95), (2034.00, 1160.24), (2035.00, 1247.65), (2036.00, 1307.53), (2037.00, 1567.28), (2038.00, 1357.43), (2039.00, 1197.8), (2040.00, 1240.62), (2041.00, 1178.76), (2042.00, 1494.31), (2043.00, 1336.53), (2044.00, 1248.26), (2045.00, 1201.06), (2046.00, 1464.66), (2047.00, 1253.74), (2048.00, 1358.8), (2049.00, 1636.48), (2050.00, 1319.7), (2051.00, 1304.95), (2052.00, 1255.27), (2053.00, 1443.44), (2054.00, 1309.65), (2055.00, 1286.09), (2056.00, 1554.15), (2057.00, 1531.21), (2058.00, 1476.12), (2059.00, 1160.58), (2060.00, 1624.21), (2061.00, 1695.21), (2062.00, 1573.9), (2063.00, 1433.26), (2064.00, 1540.66), (2065.00, 1553.46), (2066.00, 1408.92), (2067.00, 1477.64), (2068.00, 1601.26), (2069.00, 1689.66), (2070.00, 1411.99), (2071.00, 1488.44), (2072.00, 1542.34), (2073.00, 1628.16), (2074.00, 1817.87), (2075.00, 1705.97), (2076.00, 1606.47), (2077.00, 1430.03), (2078.00, 1769.11), (2079.00, 1811.83), (2080.00, 1637.3), (2081.00, 1435.05), (2082.00, 1461.1), (2083.00, 1875.98), (2084.00, 1700.22), (2085.00, 1457.08), (2086.00, 1617.37), (2087.00, 1556.22), (2088.00, 1973.38), (2089.00, 2250.34), (2090.00, 1474.76), (2091.00, 1315.89), (2092.00, 1787.84), (2093.00, 2041.03), (2094.00, 2124.54), (2095.00, 1721.06), (2096.00, 1928.98), (2097.00, 2155.15), (2098.00, 2068.71), (2099.00, 2048.87), (2100.00, 2085.43)		mm / year	Data from Climate Change Knowledge Portal, 'Projected Precipitation'. https://climateknowledgeportal.worldbank.org/country/kiribati/cmip5	
SSP370_SLR_PROJECTIONS	GRAPH(TIME) Points: (2020.00, 0.050), (2030.00, 0.099), (2040.00, 0.159), (2050.00, 0.235), (2060.00, 0.308), (2070.00, 0.398), (2080.00, 0.501), (2090.00, 0.616), (2100.00, 0.740)		meters	Projections are based on 'IPCC AR6 Sea-Level Rise Projections' specifically for Betio, South Tarawa, Kiribati (psmsl_id 1804). Median values for each SSP projection was used. Projection values are relative to a 1995-2014 baseline. This baseline was calculated to be 1.6535m from the Australian Government Bureau of Meteorology's historical sea level data.	
SSP370_SWITCH	0		Dimensionless	Switch turns on scenario for SSP 3-7.0.	
SSP370_TEMPERATURE_PROJECTIONS	GRAPH(TIME) Points: (2014.00, 26.890), (2015.00, 26.970), (2016.00, 27.040), (2017.00, 27.150), (2018.00, 27.320), (2019.00, 27.290), (2020.00, 27.000), (2021.00, 27.120), (2022.00, 27.330), (2023.00, 27.190), (2024.00, 27.090), (2025.00, 27.400), (2026.00, 27.320), (2027.00, 27.550), (2028.00, 27.430), (2029.00, 27.160), (2030.00, 27.300), (2031.00, 27.500), (2032.00, 27.490), (2033.00, 27.440), (2034.00, 27.460), (2035.00, 27.430), (2036.00, 27.540), (2037.00, 27.780), (2038.00, 27.730), (2039.00, 27.510), (2040.00, 27.560), (2041.00, 27.650), (2042.00, 27.760), (2043.00, 27.670), (2044.00, 27.680), (2045.00, 27.840), (2046.00, 28.010), (2047.00, 27.880), (2048.00, 28.030), (2049.00, 27.990), (2050.00, 27.950), (2051.00, 27.880), (2052.00, 27.990), (2053.00, 27.970), (2054.00, 28.000), (2055.00, 28.210), (2056.00, 28.250), (2057.00, 28.320), (2058.00, 28.350), (2059.00, 28.100), (2060.00, 28.480), (2061.00, 28.470), (2062.00, 28.330), (2063.00, 28.230), (2064.00, 28.440), (2065.00, 28.340), (2066.00, 28.540), (2067.00, 28.620), (2068.00, 28.760), (2069.00, 28.660), (2070.00, 28.580), (2071.00, 28.760), (2072.00, 28.860), (2073.00, 28.730), (2074.00, 28.910), (2075.00, 28.680), (2076.00, 28.610), (2077.00, 28.860), (2078.00, 28.810), (2079.00, 28.870), (2080.00, 28.990), (2081.00, 28.960), (2082.00, 29.190), (2083.00, 29.340), (2084.00, 28.980), (2085.00, 29.270), (2086.00, 29.260), (2087.00, 29.350), (2088.00, 29.590), (2089.00, 29.440), (2090.00, 29.140), (2091.00, 29.010), (2092.00, 29.340), (2093.00, 29.520), (2094.00, 29.730), (2095.00, 29.320), (2096.00, 29.630), (2097.00, 29.580), (2098.00, 29.900), (2099.00, 29.910), (2100.00, 29.680)		Degrees C	Data for projected temperature is from the World Bank Climate Knowledge Portal (Table: 'Projected Average Mean Surface Air Temperature Kiribati; (Ref. Period:1995-2014), Multi-Model Ensemble'). Source: https://climateknowledgeportal.worldbank.org/country/kiribati/climate-data-projections	

SSP585_RAINFALL_PROJECTIONS	GRAPH(TIME) Points: (2023.00, 1090.7), (2024.00, 1187.51), (2025.00, 1187.44), (2026.00, 1187.89), (2027.00, 1216.32), (2028.00, 1208.29), (2029.00, 1195.79), (2030.00, 1296.46), (2031.00, 1476.86), (2032.00, 1090.37), (2033.00, 1142.79), (2034.00, 1062.64), (2035.00, 1438.13), (2036.00, 1422.71), (2037.00, 1106.15), (2038.00, 1293.65), (2039.00, 1500.08), (2040.00, 1534.34), (2041.00, 1228.68), (2042.00, 1115.68), (2043.00, 1430.46), (2044.00, 1488.82), (2045.00, 1400.02), (2046.00, 1329.48), (2047.00, 1371.76), (2048.00, 1562.75), (2049.00, 1627.84), (2050.00, 1241.75), (2051.00, 1333.22), (2052.00, 1655.35), (2053.00, 1457.23), (2054.00, 1393.86), (2055.00, 1437.13), (2056.00, 1557.13), (2057.00, 1511.23), (2058.00, 1478.82), (2059.00, 1655.88), (2060.00, 1618.68), (2061.00, 1666.77), (2062.00, 1637.72), (2063.00, 1646.51), (2064.00, 1469.51), (2065.00, 1443.24), (2066.00, 1889.01), (2067.00, 1633.96), (2068.00, 1255.64), (2069.00, 1892.83), (2070.00, 1931.08), (2071.00, 1640.38), (2072.00, 1328.43), (2073.00, 1975.1), (2074.00, 1860.67), (2075.00, 1721.82), (2076.00, 1708.73), (2077.00, 1458.36), (2078.00, 1509.08), (2079.00, 1908.96), (2080.00, 1750.88), (2081.00, 1837.98), (2082.00, 1776.76), (2083.00, 1682.2), (2084.00, 1594.2), (2085.00, 2161.66), (2086.00, 1836.84), (2087.00, 2001.99), (2088.00, 1919.98), (2089.00, 1753.03), (2090.00, 2064.48), (2091.00, 2269.25), (2092.00, 1682.81), (2093.00, 1878.97), (2094.00, 2585.36), (2095.00, 2020.26), (2096.00, 2321.99), (2097.00, 2158.2), (2098.00, 2295.86), (2099.00, 2001.93), (2100.00, 2143.09)		mm / year	Data from Climate Change Knowledge Portal, 'Projected Precipitation'. https://climateknowledgeportal.worldbank.org/country/kiribati/cmip5	
SSP585_SLR_PROJECTIONS	GRAPH(TIME) Points: (2020.00, 0.060), (2030.00, 0.111), (2040.00, 0.169), (2050.00, 0.250), (2060.00, 0.334), (2070.00, 0.439), (2080.00, 0.554), (2090.00, 0.692), (2100.00, 0.826)		meters	Projections are based on 'IPCC AR6 Sea-Level Rise Projections' specifically for Betio, South Tarawa, Kiribati (psmsl_id 1804). Median values for each SSP projection was used. Projection values are relative to a 1995-2014 baseline. This baseline was calculated to be 1.6535m from the Australian Government Bureau of Meteorology's historical sea level data.	
SSP585_SWITCH	1		Dimensionless	Switch turns on scenario for SSP 5-8.5.	
SSP585_TEMPERATURE_PROJECTIONS	GRAPH(TIME) Points: (2014.00, 26.890), (2015.00, 27.110), (2016.00, 27.200), (2017.00, 27.260), (2018.00, 27.230), (2019.00, 26.980), (2020.00, 27.210), (2021.00, 27.270), (2022.00, 27.190), (2023.00, 27.280), (2024.00, 27.280), (2025.00, 27.290), (2026.00, 27.450), (2027.00, 27.430), (2028.00, 27.520), (2029.00, 27.410), (2030.00, 27.470), (2031.00, 27.580), (2032.00, 27.400), (2033.00, 27.340), (2034.00, 27.520), (2035.00, 27.730), (2036.00, 27.680), (2037.00, 27.570), (2038.00, 27.820), (2039.00, 28.000), (2040.00, 28.040), (2041.00, 27.810), (2042.00, 27.840), (2043.00, 28.110), (2044.00, 28.220), (2045.00, 28.190), (2046.00, 27.900), (2047.00, 28.060), (2048.00, 28.320), (2049.00, 28.210), (2050.00, 28.060), (2051.00, 28.270), (2052.00, 28.190), (2053.00, 28.310), (2054.00, 28.260), (2055.00, 28.350), (2056.00, 28.380), (2057.00, 28.620), (2058.00, 28.680), (2059.00, 28.790), (2060.00, 28.590), (2061.00, 28.830), (2062.00, 28.810), (2063.00, 28.750), (2064.00, 28.870), (2065.00, 28.900), (2066.00, 29.020), (2067.00, 29.020), (2068.00, 28.890), (2069.00, 29.140), (2070.00, 29.250), (2071.00, 29.300), (2072.00, 29.240), (2073.00, 29.300), (2074.00, 29.560), (2075.00, 29.310), (2076.00, 29.570), (2077.00, 29.320), (2078.00, 29.500), (2079.00, 29.520), (2080.00, 29.680), (2081.00, 29.750), (2082.00, 29.870), (2083.00, 29.810), (2084.00, 29.700), (2085.00, 30.050), (2086.00, 29.940), (2087.00, 30.080), (2088.00, 29.970), (2089.00, 29.950), (2090.00, 30.290), (2091.00, 30.260), (2092.00, 30.090), (2093.00, 30.240), (2094.00, 30.420), (2095.00, 30.250), (2096.00, 30.540), (2097.00, 30.470), (2098.00, 30.460), (2099.00, 30.470), (2100.00, 30.490)		Degrees C	Data for projected temperature is from the World Bank Climate Knowledge Portal (Table: 'Projected Average Mean Surface Air Temperature Kiribati; (Ref. Period:1995-2014), Multi-Model Ensemble'). Source: https://climateknowledgeportal.worldbank.org/country/kiribati/climate-data-projections	

Demographics:

Population_in_Outer_Islands(t)	Population_in_Outer_Islands(t - dt) + (outer_islands_births + S_Tarawa_to_outer_islands_flow - outer_islands_to_S_Tarawa_flow - outer_islands_deaths - "out-migration_from_the_outer_islands") * dt	INIT Population_in_Outer_Islands = 46995	people	Initial population for outer islands was calculated from the 'Total' population (72,335) minus the population of South Tarawa (25,380) for the year 1990 = 46,955 people. Source: Kiribati Census Atlas 2022	NON-NEGATIVE
Population_in_Tarawa(t)	Population_in_Tarawa(t - dt) + (births + outer_islands_to_S_Tarawa_flow - deaths - "out-migration_from_S_Tarawa" - S_Tarawa_to_outer_islands_flow) * dt	INIT Population_in_Tarawa = 25380	people	The census count for South Tarawa in 1990 was 25380 people. Source: Kiribati Census Atlas 2022	NON-NEGATIVE
births	Population_in_Tarawa*Tarawa.birthrate_in_Tarawa		people/Years	This flow represents the birth rate for South Tarawa.	
deaths	Population_in_Tarawa*REFERENCE_DEATH_RATE	OUTFLOW PRIORITY: 1	people/years	This flow represents the death rate for South Tarawa.	
"out-migration_from_S_Tarawa"	Population_in_Tarawa*Utility_Functions.probability_of_moving_abroad_from_S_Tarawa	OUTFLOW PRIORITY: 2	people/years	This flow represents the rate of people moving abroad from South Tarawa.	
"out-migration_from_the_outer_islands"	(Population_in_Outer_Islands*Utility_Functions.probability_of_moving_abroad_from_outer_islands)	OUTFLOW PRIORITY: 3	people/years	This flow represents the rate of people moving abroad from the outer islands.	
outer_islands_births	Population_in_Outer_Islands*birthrate_in_outer_islands		people/Years	This flow represents the birth rate for the outer islands.	
outer_islands_deaths	Population_in_Outer_Islands*REFERENCE_DEATH_RATE	OUTFLOW PRIORITY: 2	people/Years	This flow represents the death rate for the outer islands.	
outer_islands_to_S_Tarawa_flow	(Population_in_Outer_Islands*Utility_Functions.probability_of_moving_to_S_Tarawa_from_outer_islands)	OUTFLOW PRIORITY: 1	people/Years	The flow represents the rate of people from the outer islands moving to South Tarawa.	
S_Tarawa_to_outer_islands_flow	(Population_in_Tarawa*Utility_Functions.probability_of_moving_to_the_outer_islands_from_S_Tarawa)	OUTFLOW PRIORITY: 3	people/years	The flow represents the rate of people from South Tarawa moving to the outer islands.	UNIFLOW
birthrate_in_outer_islands	NATIONAL_BIRTHRATE/1000		people/(people * year)	Birthrate is divided by 1000 to account for the historical crude birthrate of 1 birth per 1000 people.	
NATIONAL_BIRTHRATE	30000000*EXP(-0.007*TIME)		people/(people * year)	Data is available for crude birthrates at a national level for Kiribati. A logarithmic trend line was used to fit Kiribati birthrate data from 1960-2022. Source: https://data.worldbank.org/indicator/SP.DYN.CBRT.IN?locations=KI	
REFERENCE_DEATH_RATE	0.007		people/(people* year)	Average deathrate calculated from 1990-2021 is 7 deaths/ 1000 people. Deathrate is divided by 1000 to account for the historical crude deathrate of 1 death per 1000 people. Source: https://data.worldbank.org/indicator/SP.DYN.CDRT.IN?locations=KI	
International:					
"I-Kiribati_Abroad"(t)	"I-Kiribati_Abroad"(t - dt) + (- migration_from_Kiribati) * dt	INIT "I-Kiribati_Abroad" = 5000	people	This stock represents the number of I-Kiribati who have moved abroad. This is outside the model boundary.	
migration_from_Kiribati	Demographics."out-migration_from_S_Tarawa"+Demographics."out-migration_from_the_outer_islands"		people/Years	This flow represents the rate of people moving abroad from Kiribati (both from South Tarawa and the outer islands). This flow is only included for comparison to historic data.	
Outer_Islands:					
Land_in_Outer_Islands(t)	Land_in_Outer_Islands(t - dt) + (land_expansion - land_loss) * dt	INIT Land_in_Outer_Islands = 326	sq km	Calculated from total land area minus land areas of South Tarawa and Kiritmati (Table 5 of Kiribati Census Atlas 2022).	
land_expansion	Land_in_Outer_Islands*Tarawa.ACCRETION_RATE		sq km/year	Land expansion in the outer islands only includes natural accretion. No reclamation is considered.	
land_loss	Land_in_Outer_Islands*(Climate_Impacts.function_for_effect_of_sea_level_rise_on_land_loss+Tarawa.EROSION_RATE)		sq km / year	Land loss is calculated from erosion rates as well as anticipated exacerbation of land loss from sea level rise.	
avg_per_capita_income_in_the_outer_islands	IF Climate_Impacts.SSP119_SWITCH = 1 THEN SSP119_CLIMATE_EFFECTS_ON_INCOME_IN_OUTER_ISLANDS ELSE (IF Climate_Impacts.SSP126_SWITCH = 1 THEN SSP126_CLIMATE_EFFECTS_ON_INCOME_IN_OUTER_ISLANDS ELSE (IF Climate_Impacts.SSP245_SWITCH = 1 THEN SSP245_CLIMATE_EFFECTS_ON_INCOME_IN_OUTER_ISLANDS ELSE (IF Climate_Impacts.SSP370_SWITCH = 1 THEN SSP370_CLIMATE_EFFECTS_ON_INCOME_IN_OUTER_ISLANDS ELSE (IF Climate_Impacts.SSP585_SWITCH = 1 THEN SSP585_CLIMATE_EFFECTS_ON_INCOME_IN_OUTER_ISLANDS ELSE NO_CLIMATE_EFFECTS_ON_INCOME_IN_OUTER_ISLANDS))))		Dimensionless	Average per capita household income based on estimated relationships for each SSP.	

BASE_EMOTIONAL_COST_OF_MOVEMENT_ABROAD	50940.34349		Dimensionless	Base emotional cost of moving abroad is calculated through a calibration optimization of population movement. This value represents the emotional cost of leaving home (ancestral lands), especially relevant in the Pacific where place attachment is high.	
BASE_EMOTIONAL_COST_OF_MOVEMENT_INTERNAL	49194.57802		Dimensionless	Base emotional cost of internal movement is calculated through a calibration optimization of population movement. This value represents the emotional cost of leaving home (ancestral lands), especially relevant in the Pacific where place attachment is high.	
effect_of_funding_on_quality_of_infrastructure_and_services	GRAPH(government_funding_to_outer_islands//INIT(government_funding_to_outer_islands)) Points: (0.000, 0.000), (0.200, 0.5073), (0.400, 0.8946), (0.600, 1.190), (0.800, 1.416), (1.000, 1.588), (1.200, 1.720), (1.400, 1.820), (1.600, 1.897), (1.800, 1.955), (2.000, 2.000)		Dimensionless	The relationship of infrastructure and services quality to funding was based on the researcher's judgement.	
effect_of_infrastructure_and_social_service_quality_on_outer_island_attractiveness	GRAPH(infrastructure_and_social_services_quality // IDEAL_INFRASTRUCTURE_AND_SOCIAL_SERVICES_QUALITY) Points: (0.000, 0.000), (0.100, 0.2277), (0.200, 0.4089), (0.300, 0.5529), (0.400, 0.6675), (0.500, 0.7586), (0.600, 0.8311), (0.700, 0.8887), (0.800, 0.9345), (0.900, 0.971), (1.000, 1.000)		Dimensionless	This relationship represents how the attractiveness of being (staying) in the outer islands is affected by the infrastructure and social services quality. The relationship assumes that there is not a 1:1 ratio of service quality to attractiveness.	
effect_of_land_loss_on_emotional_cost	(1-((INIT(Land_in_Outer_Islands)-Land_in_Outer_Islands)/INIT(Land_in_Outer_Islands)))		Dimensionless	The effect of land loss on emotional cost relationship assumed that the emotional cost of movement will decrease as land is lost.	
effect_of_land_loss_on_infrastructure	GRAPH(Land_in_Outer_Islands//INITIAL_LAND_OUTER_ISLANDS) Points: (0.000, 0.000), (0.100, 0.3352), (0.200, 0.5601), (0.300, 0.7111), (0.400, 0.8123), (0.500, 0.8803), (0.600, 0.9259), (0.700, 0.9565), (0.800, 0.977), (0.900, 0.9908), (1.000, 1.000)		Dimensionless	This relationship assumes that not all land lost will have been occupied by infrastructure in the outer islands. Effect of land loss is on the total loss of the infrastructure.	
effect_of_land_loss_on_outer_island_attractiveness	GRAPH(Land_in_Outer_Islands//INITIAL_LAND_OUTER_ISLANDS) Points: (0.000, 0.000), (0.100, 0.124), (0.200, 0.2419), (0.300, 0.354), (0.400, 0.4607), (0.500, 0.5622), (0.600, 0.6587), (0.700, 0.7505), (0.800, 0.832), (0.900, 0.921), (1.000, 1.000)		Dimensionless	This estimated relationship represents how the attractiveness of staying (being) in the outer islands declines as land is lost.	
government_funding_to_outer_islands	Demographics.Population_in_Outer_Islands*Finances.GOVNT_FUNDING_PER_CAPITA_IN_OUTER_ISLANDS		Australian Dollars/Year	Total funding to the outer islands is the per capita funding times the dynamic population.	
IDEAL_INFRASTRUCTURE_AND_SOCIAL_SERVICES_QUALITY	1		Dimensionless	Assumed ideal infrastructure and social service quality of 1.	
IDEAL_WATER_ACCESS	1		Dimensionless	Ideal water access would be 100% (value of 1).	
infrastructure_and_social_services_quality	((0.7)*effect_of_funding_on_quality_of_infrastructure_and_services+(0.3)*effect_of_land_loss_on_infrastructure)*REFERENCE_INFRASTRUCTURE_AND_SOCIAL_SERVICES_QUALITY		Dimensionless	The reference infrastructure and social services quality in the outer islands is dynamically affected by government funding to the outer islands and effects of climate change on service quality. These contributions were weighted through researcher judgment to reflect a higher influence of funding on service and infrastructure quality.	
INITIAL_LAND_OUTER_ISLANDS	326		sq km	Calculated from total land area minus land areas of South Tarawa and Kiritmati (Table 5 of Kiribati Census Atlas 2022).	
NO_CLIMATE_EFFECTS_ON_INCOME_IN_OUTER_ISLANDS	GRAPH(TIME) Points: (1990.0, 500), (2000.0, 1000), (2006.0, 1324), (2019.0, 2593), (2030.0, 3250), (2040.0, 3920), (2050.0, 4350), (2060.0, 4760), (2070.0, 5140), (2080.0, 5510), (2090.0, 5800), (2100.0, 6000)		Dimensionless	Relationship estimated from discussions of climate change's anticipated effect on income in the outer islands. Historic income in the outer islands was used for 2006 ($1,324AUD) and 2019 ($2,593AUD). Source: 2006 (Table 3.3) and 2019 (Table 139) Kiribati Household Income and Expenditures Survey	
REFERENCE_INFRASTRUCTURE_AND_SOCIAL_SERVICES_QUALITY	0.2		Dimensionless	A value of 0.20 was estimated from discussions with local partners. A low reference value reflects lack of development in the outer islands.	
REFERENCE_WATER_AVAILABILITY_IN_OUTER_ISLANDS	0.7		Dimensionless	This reference value was estimated from discussions with local partners.	
SSP119_CLIMATE_EFFECTS_ON_INCOME_IN_OUTER_ISLANDS	GRAPH(TIME) Points: (1990.0, 500), (2000.0, 1000), (2006.0, 1324), (2019.0, 2593), (2030.0, 3730), (2040.0, 4210), (2050.0, 4540), (2060.0, 4740), (2070.0, 4890), (2080.0, 5000), (2090.0, 5000), (2100.0, 5000)		Dimensionless	Relationship estimated from discussions of climate change's anticipated effect on income in the outer islands. Historic income in the outer islands was used for 2006 ($1,324AUD) and 2019 ($2,593AUD).	

	(2100.0, 5000)			Source: 2006 (Table 3.3) and 2019 (Table 139) Kiribati Household Income and Expenditures Survey	
SSP119_CLIMATE_EFFECTS_ON_WATER_AVAILABILITY_IN_OUTER_ISLANDS	GRAPH(TIME) Points: (1990.0, 1.000), (2002.22222222, 0.9444), (2014.44444444, 0.8889), (2026.66666667, 0.8333), (2038.88888889, 0.7778), (2051.11111111, 0.7222), (2063.33333333, 0.6667), (2075.55555556, 0.6111), (2087.77777778, 0.5556), (2100.0, 0.500)		Dimensionless	The relationship shown matches trends anticipated from discussants with local partners. These trends do not match the IPCC projections for future rainfall for the country. For this relationship, local knowledge and expertise was used. However, these downward trends do not necessarily apply to all outer islands. Some outer islands receive sufficient rainfall to meet needs. This trend shows the most extreme water cases in the outer islands to show the highest range potential for movement.	
SSP126_CLIMATE_EFFECTS_ON_INCOME_IN_OUTER_ISLANDS	GRAPH(TIME) Points: (1990.0, 500), (2000.0, 1000), (2006.0, 1324), (2019.0, 2593), (2030.0, 3100), (2040.0, 3530), (2050.0, 3850), (2060.0, 4170), (2070.0, 4420), (2080.0, 4500), (2090.0, 4610), (2100.0, 4610)		Dimensionless	Relationship estimated from discussions of climate change's anticipated effect on income in the outer islands. Historic income in the outer islands was used for 2006 ($1,324AUD) and 2019 ($2,593AUD). Source: 2006 (Table 3.3) and 2019 (Table 139) Kiribati Household Income and Expenditures Survey	
SSP126_CLIMATE_EFFECTS_ON_WATER_AVAILABILITY_IN_OUTER_ISLANDS	GRAPH(TIME) Points: (1990.0, 1.000), (2002.22222222, 0.9389), (2014.44444444, 0.8778), (2026.66666667, 0.8167), (2038.88888889, 0.7556), (2051.11111111, 0.6944), (2063.33333333, 0.6333), (2075.55555556, 0.5722), (2087.77777778, 0.5111), (2100.0, 0.450)		Dimensionless	The relationship shown matches trends anticipated from discussants with local partners. These trends do not match the IPCC projections for future rainfall for the country. For this relationship, local knowledge and expertise was used. However, these downward trends do not necessarily apply to all outer islands. Some outer islands receive sufficient rainfall to meet needs. This trend shows the most extreme water cases in the outer islands to show the highest range potential for movement.	
SSP245_CLIMATE_EFFECTS_ON_INCOME_IN_OUTER_ISLANDS	GRAPH(TIME) Points: (1990.0, 500), (2000.0, 1000), (2006.0, 1324), (2019.0, 2593), (2030.0, 3230), (2040.0, 3400), (2050.0, 3530), (2060.0, 3640), (2070.0, 3730), (2080.0, 3820), (2090.0, 3920), (2100.0, 3950)		Dimensionless	Relationship estimated from discussions of climate change's anticipated effect on income in the outer islands. Historic income in the outer islands was used for 2006 ($1,324AUD) and 2019 ($2,593AUD). Source: 2006 (Table 3.3) and 2019 (Table 139) Kiribati Household Income and Expenditures Survey	
SSP245_CLIMATE_EFFECTS_ON_WATER_AVAILABILITY_IN_OUTER_ISLANDS	GRAPH(TIME) Points: (1990.0, 1.000), (2002.22222222, 0.9333), (2014.44444444, 0.8667), (2026.66666667, 0.800), (2038.88888889, 0.7333), (2051.11111111, 0.6667), (2063.33333333, 0.600), (2075.55555556, 0.5333), (2087.77777778, 0.4667), (2100.0, 0.400)		Dimensionless	The relationship shown matches trends anticipated from discussants with local partners. These trends do not match the IPCC projections for future rainfall for the country. For this relationship, local knowledge and expertise was used. However, these downward trends do not necessarily apply to all outer islands. Some outer islands receive sufficient rainfall to meet needs. This trend shows the most extreme water cases in the outer islands to show the highest range potential for movement.	
SSP370_CLIMATE_EFFECTS_ON_INCOME_IN_OUTER_ISLANDS	GRAPH(TIME) Points: (1990.0, 500), (2000.0, 1000), (2006.0, 1324), (2019.0, 2593), (2030.0, 3020), (2040.0, 3260), (2050.0, 3400), (2060.0, 3510), (2070.0, 3560), (2080.0, 3570), (2090.0, 3570), (2100.0, 3590)		Dimensionless	Relationship estimated from discussions of climate change's anticipated effect on income in the outer islands. Historic income in the outer islands was used for 2006 ($1,324AUD) and 2019 ($2,593AUD). Source: 2006 (Table 3.3) and 2019 (Table 139) Kiribati Household Income and Expenditures Survey	

SSP370_CLIMATE_EFFECTS_ON_WATER_AVAILABILITY_IN_OUTER_ISLANDS	GRAPH(TIME) Points: (1990.0, 1.000), (2002.22222222, 0.9278), (2014.44444444, 0.8556), (2026.66666667, 0.7833), (2038.88888889, 0.7111), (2051.11111111, 0.6389), (2063.33333333, 0.5667), (2075.55555556, 0.4944), (2087.77777778, 0.4222), (2100.0, 0.350)		Dimensionless	The relationship shown matches trends anticipated from discussants with local partners. These trends do not match the IPCC projections for future rainfall for the country. For this relationship, local knowledge and expertise was used. However, these downward trends do not necessarily apply to all outer islands. Some outer islands receive sufficient rainfall to meet needs. This trend shows the most extreme water cases in the outer islands to show the highest range potential for movement.	
SSP585_CLIMATE_EFFECTS_ON_INCOME_IN_OUTER_ISLANDS	GRAPH(TIME) Points: (1990.0, 500), (2000.0, 1000), (2006.0, 1324), (2019.0, 2593), (2030.0, 2960), (2040.0, 3100), (2050.0, 3270), (2060.0, 3350), (2070.0, 3350), (2080.0, 3370), (2090.0, 3370), (2100.0, 3350)		Dimensionless	Relationship estimated from discussions of climate change's anticipated effect on income in the outer islands. Historic income in the outer islands was used for 2006 ($1,324AUD) and 2019 ($2,593AUD). Source: 2006 (Table 3.3) and 2019 (Table 139) Kiribati Household Income and Expenditures Survey	
SSP585_CLIMATE_EFFECTS_ON_WATER_AVAILABILITY_IN_OUTER_ISLANDS	GRAPH(TIME) Points: (1990.0, 1.000), (2002.22222222, 0.9222), (2014.44444444, 0.8444), (2026.66666667, 0.7667), (2038.88888889, 0.6889), (2051.11111111, 0.6111), (2063.33333333, 0.5333), (2075.55555556, 0.4556), (2087.77777778, 0.3778), (2100.0, 0.300)		Dimensionless	The relationship shown matches trends anticipated from discussants with local partners. These trends do not match the IPCC projections for future rainfall for the country. For this relationship, local knowledge and expertise was used. However, these downward trends do not necessarily apply to all outer islands. Some outer islands receive sufficient rainfall to meet needs. This trend shows the most extreme water cases in the outer islands to show the highest range potential for movement.	
total_emotional_cost_of_movement_abroad	BASE_EMOTIONAL_COST_OF_MOVEMENT_ABROAD*effect_of_land_loss_on_emotional_cost		Dimensionless	The total emotional cost of movement abroad accounts for the base emotional cost and the effect that land loss may have had on it.	
total_emotional_cost_of_movement_internal	BASE_EMOTIONAL_COST_OF_MOVEMENT_INTERNAL*effect_of_land_loss_on_emotional_cost		Dimensionless	The total emotional cost of internal movement accounts for the base emotional cost and the effect that land loss may have had on it.	
water_adequacy_ratio	water_availability_in_outer_islands/IDEAL_WATER_ACCESS		Dimensionless	Water adequacy is the amount that is available divided by the ideal amount.	
water_availability_in_outer_islands	REFERENCE_WATER_AVAILABILITY_IN_OUTER_ISLANDS* IF Climate_Impacts.SSP119_SWITCH = 1 THEN SSP119_CLIMATE_EFFECTS_ON_WATER_AVAILABILITY_IN_OUTER_ISLANDS ELSE (IF Climate_Impacts.SSP126_SWITCH = 1 THEN SSP126_CLIMATE_EFFECTS_ON_WATER_AVAILABILITY_IN_OUTER_ISLANDS ELSE (IF Climate_Impacts.SSP245_SWITCH = 1 THEN SSP245_CLIMATE_EFFECTS_ON_WATER_AVAILABILITY_IN_OUTER_ISLANDS ELSE (IF Climate_Impacts.SSP370_SWITCH = 1 THEN SSP370_CLIMATE_EFFECTS_ON_WATER_AVAILABILITY_IN_OUTER_ISLANDS ELSE (IF Climate_Impacts.SSP585_SWITCH = 1 THEN SSP585_CLIMATE_EFFECTS_ON_WATER_AVAILABILITY_IN_OUTER_ISLANDS ELSE 1))))		Dimensionless	Water availability in the outer islands based on estimated relationships for each SSP.	
Tarawa:					
Housing_Units(t)	Housing_Units(t - dt) + (housing_development - houses_lost) * dt	INIT Housing_Units = 2786	housing unit	Based on a linear trendline from household counts in 2005, 2010, 2015, and 2022 there was an estimated 1692 households in 1990. Source: Kiribati 2006 Household Income and Expenditures Report	NON-NEGATIVE
Land_Area(t)	Land_Area(t - dt) + (land_expansion - land_loss) * dt	INIT Land_Area = 11.8	sq km	South Tarawa land area values for 1968 and 1998 were interpolated to find the estimated land area in 1990. Source: Table 3 Summary of area changes for the two areas, and the entire atoll, over the 30-year period (1968–1998) Biribo & Woodroffe (2013)	
Residential_Land_Area(t)	Residential_Land_Area(t - dt) + (developing_residential_land - residential_land_loss) * dt	INIT Residential_Land_Area = 5.17	sq km	Map areas for residential land were calculated from pdf measurement tool using the 2017 National Government Land Use Plan.	

Undeveloped_Land_Area(t)	Undeveloped_Land_Area(t - dt) + (gaining_undeveloped_land - loss_of_open_land - developing_open_land) * dt	INIT Undeveloped_Land_Area = 0.2	sq km	Map areas for undeveloped land were calculated from pdf measurement tool using the 2017 National Government Land Use Plan.	NON-NEGATIVE
developing_open_land	housing_development/(HOUSING_BUILDING_PER_PROPERTY/HOUSE_FOOTPRINT_FOR_NEW_BUILDS*SQ_M_TO_SQ_KM_CONVERSION* IF SWITCH_HOUSING_LEVELS = 1 THEN HOUSING_LEVELS ELSE 1)	OUTFLOW PRIORITY: 2	sq km / year	Development of open land is based on housing development.	
developing_residential_land	developing_open_land		sq km/year	As open land development is currently only based on housing development, this value is also used as the amount of land added for residential land area.	
gaining_undeveloped_land	land_expansion*PERCENT_OF_NEW_LAND_THAT_CAN_BE_DEVELOPED+(HOUSING_BUILDING_OUT_OF_USE_RATE/(HOUSING_BUILDING_PER_PROPERTY*PROPERTY_SIZE))		sq km/year	New undeveloped land comes from land expansion and land where buildings are destroyed.	
houses_lost	(HOUSING_BUILDING_OUT_OF_USE_RATE+housing_building_lost_to_SLR)* IF SWITCH_HOUSING_LEVELS = 1 THEN HOUSING_LEVELS ELSE 1		housing unit / years	Five houses are estimated to be lost per year from damage. Additional house loss from from loss of land.	
housing_development	("AVG._HOUSING_DEVELOPMENT_RATE"* IF SWITCH_HOUSING_LEVELS = 1 THEN HOUSING_LEVELS ELSE 1) + housing_units_needed_for_new_people		housing unit / years	The housing development rate is calculated from the average housing development rate plus the units needed to accommodate new people in South Tarawa. New housing development can be built upward in multistory housing if policy option is turned on.	
land_expansion	SMTH1((ACCRETION_RATE*Land_Area)+RECLAMATION_RATE, 10)		sq km/Years	Total new land from both reclaimed land and natural accretion.	
land_loss	Land_Area*(Climate_Impacts.function_for_effect_of_sea_level_rise_on_land_loss+EROSION_RATE)		sq km/Years	Land loss is calculated from erosion rates as well as anticipated exacerbation of land loss from sea level rise.	
loss_of_open_land	land_loss*percent_of_land_area_undeveloped	OUTFLOW PRIORITY: 1	sq km / year	Land loss to undeveloped area from erosion and sea level rise is assumed to be proportional to percent of undeveloped land to total land area.	
residential_land_loss	land_loss*percent_of_residential_land_area		sq km/year	Land loss to residential land area from erosion and sea level rise is assumed to be proportional to percent of residential land to total land area.	
"AVG._HOUSING_DEVELOPMENT_RATE"	39.89720007		housing building/ year	This rate was calculated through a calibration optimization of household density.	
"AVG._LIFE_EXPECTANCY"	65		years	Average life expectancy was calculated as the mean life expectancy between 1990-2021. Source: https://data.worldbank.org/indicator/SP.DYN.LE00.IN?end=2021&locations=KI&start=1990	
"PERCENT_OF_POP._WOMEN"	0.52		women / people	Source: Kiribati Census Atlas 2022	
"population_density_in_S._Tarawa"	Demographics.Population_in_Tarawa//Land_Area		People/Kilometers^2	Population density is calculated from the population in South Tarawa divided by the total land area.	
"REF._PERCENT_MOVING_IN_WITH_FAMILY"	0.210064222		Dimensionless	This value was calculated through a calibration optimization of household density.	
ACCRETION_RATE	0.001		1 / years	Table 9 of Biribo & Woodroffe et al. (2013) provides the percent accretion for 8 measurement locations in South Tarawa, for both their lagoon and ocean sides. The average of both lagoon and ocean sides were taken for each location, then all 8 locations were averaged. Table 6 of the same study indicates that only 11% of accretion is natural (as opposed to reclamation). As reclamation is separated in this model, only 11% of the accretion rate from Table 9 was used. Overall, there was calculated to be a 3% accretion of land area over the period of 1968-1998. This value was divided by 30 to calculate accretion per year (0.105%/year). Source: Biribo & Woodroffe (2013)	
BASE_EMOTIONAL_COST_OF_MOVEMENT_ABROAD	50951.82163		Dimensionless	Base emotional cost of moving abroad is calculated through a calibration optimization of population movement. This value represents the emotional cost of leaving home (ancestral lands), especially relevant in the Pacific where place attachment is high.	

BASE_EMOTIONAL_COST_OF_MOVEMENT_INTERNAL	49196.2986		Dimensionless	Base emotional cost of internal movement is calculated through a calibration optimization of population movement. This value represents the emotional cost of leaving home (ancestral lands), especially relevant in the Pacific where place attachment is high.	
birthrate_in_Tarawa	(LOOKUP(FERTILITY_BY_POPULATION_DENSITY, ("population_density_in_S._Tarawa")))*"PERCENT_OF_POP._WOMEN"/"AVG._LIFE_EXPECTANCY"		people / (people*year)	The fertility rate is based on the relationship with the population density. As fertility rate is expressed as births/woman, it is multiplied by the sex ratio in South Tarawa and divided by the life expectancy.	
effect_of_land_loss_on_emotional_cost	1-((INIT(Land_Area)-Land_Area)/INIT(Land_Area))		Dimensionless	The effect of land loss on emotional cost relationship assumed that the emotional cost of movement will decrease as land is lost.	
effect_of_land_loss_on_S_Tarawa_attractiveness	GRAPH(Land_Area//INIT(Land_Area)) Points: (0.000, 0.000), (0.100, 0.124), (0.200, 0.2419), (0.300, 0.354), (0.400, 0.4607), (0.500, 0.5622), (0.600, 0.6587), (0.700, 0.7505), (0.800, 0.832), (0.900, 0.921), (1.000, 1.000)		Dimensionless	This estimated relationship represents how the attractiveness of staying (being) in South Tarawa declines as land is lost.	
effect_variable_of_land_availability_on_moving_in_with_family	-0.014507824		Dimensionless	This value was calculated through a calibration optimization of household density.	
EROSION_RATE	0.00457		1/ year	Table 9 of Biribo & Woodroffe et al. (2013) provides the percent erosion for 8 measurement locations in South Tarawa, for both their lagoon and ocean sides. The average of both lagoon and ocean sides were taken for each location, then all 8 locations were averaged. Overall, there was calculated to be a 14% erosion of land area over the period of 1968-1998. This value was divided by 30 to calculate the erosion per year (0.457%/year).	
FERTILITY_BY_POPULATION_DENSITY	GRAPH("population_density_in_S._Tarawa"//INIT("population_density_in_S._Tarawa")) Points: (380, 6.781), (709.272727273, 6.040), (1038.54545455, 4.997), (1367.81818182, 5.100), (1697.09090909, 4.920), (2026.36363636, 4.701), (2355.63636364, 4.411), (2684.90909091, 4.103), (3014.18181818, 3.928), (3343.45454545, 3.843), (3672.72727273, 3.706), (4002, 3.300)		people/ (women)	Rotella et al. (2021) provides data on the relationship between national population density and national fertility rates. National fertility rates provided here were assumed to apply similarly to South Tarawa, though population density was much higher in the same time period. This graphical converter shows the national fertility rates per population density in South Tarawa. Population density in South Tarawa was calculated from national census data. The time period for this data is 1963-2020. Sources: Fertility data: Rotella A, Varnum MEW, Sng O, Grossmann I. Increasing population densities predict decreasing fertility rates over time: A 174-nation investigation. Am Psychol. 2021 Sep;76(6):933-946. doi: 10.1037/amp0000862. PMID: 34914431. Population density data: Historical Census Data.	
function_of_effect_of_land_availability_on_moving_in_with_family	(Undeveloped_Land_Area//INITIAL_OPEN_LAND)*effect_variable_of_land_availability_on_moving_in_with_family+y_axis		Dimensionless	Function represents linear relationship between open land area and the percent of people moving in with family where x is the change in land availability and the slope and y intercept were calibrated to historic household data.	
FUTURE_RECLAMATION_RATE	0		sq km/ years	This variable is included for future policy analysis. It is currently set at 0 to show the effects of no future reclamation.	
HISTORIC_RECLAMATION_RATE	0.222366614		sq km/ year	Rate calibrated to match current land area (15.76 sqkm).	
HOUSE_FOOTPRINT_FOR_NEW_BUILDS	70		sq m / property	Gives footprint of concrete (80 sq m) and timber (60 sq m) in Fiji. Average of 70 sq m is used. Fiji can be used as a proximate for Kiribati housing structure. This assumes that new builds have no space in their property outside of the dimensions of their house. Source: 'UNDP Pacific Housing Guide 2023'.	
household_density_for_new_migrants	4.394004541		people/ housing unit	This density was calculated through a calibration optimization of household density.	

housing_building_lost_to_SLR	residential_land_loss*PROPERTY_SIZE*HOUSING_BUILDING_PER_PROPERTY		housing building/Year	Calculation of how many housing buildings would be lost to sea level rise based on residential land loss.	
HOUSING_BUILDING_OUT_OF_USE_RATE	26.19129499		housing building / year	This out of use rate was calculated through a calibration optimization of household density.	
HOUSING_BUILDING_PER_PROPERTY	1		housing building/ property	There value indicated there is 1 housing building per property.	
HOUSING_LEVELS	3		housing unit / housing building	Housing levels represent the number of stories a housing building could have. This value is used to indicate the number of units in a building, assuming one unit per level.	
housing_units_needed_for_new_people	new_people_to_Tarawa/household_density_for_new_migrants*(1-percent_of_new_people_moving_in_with_family)		housing unit / year	Housing units needed calculated from the new people in South Tarawa divided by the household density for new people times the percentage that are likely to move into their own housing (100% minus the percent moving in with family).	
INITIAL_OPEN_LAND	0.222636758		sq km	Map areas were calculated from pdf measurement tool using the 2017 National Government Land Use Plan. Same value as initial for 'Undeveloped Land Area'.	
new_people_to_Tarawa	Demographics.births+Demographics.outer_islands_to_S_Tarawa_flow		people/ years	New people to Tarawa are calculated from births and in-migration.	
overall_household_density_in_Tarawa	Demographics.Population_in_Tarawa/Housing_Units		people/ housing unit	Household density calculated as population in South Tarawa divided by the housing units.	
percent_of_land_area_undeveloped	Undeveloped_Land_Area/Land_Area		Dimensionless	Calculated from the amount of undeveloped land area and the total land area.	
PERCENT_OF_NEW_LAND_THAT_CAN_BE_DEVELOPED	0.237370083		Dimensionless	This value was calculated through a calibration optimization of household density. It is assumed that not all new land added can be developed on. For example, shoreline accretion may only add minimal amounts to existing property.	
percent_of_new_people_moving_in_with_family	("REF._PERCENT_MOVING_IN_WITH_FAMILY"*function_of_effect_of_land_availability_on_moving_in_with_family)		Dimensionless	This function represents the amount of people that will choose to move in with family based on the available land.	
percent_of_residential_land_area	Residential_Land_Area//Land_Area		Dimensionless	Calculated from the amount of residential land area and the total land area.	
PROPERTY_SIZE	540		property /sq km	The initial values for housing units (2786 houses) and residential land (5.17 sq km) at time 0 were used to find the average square area per household land (0.001856 sq km / house). Using this value, it is estimated that 540 houses would be lost per 1 sq km of residential land lost.	
RECLAMATION_RATE	(IF TIME < year_reclamation_tapered THEN HISTORIC_RECLAMATION_RATE ELSE FUTURE_RECLAMATION_RATE)		sq km/ years	Total net area by reclamation (363sq km from 1968-1998) was divided by 30 to find reclamation rate per year. Reclamation rate per year= 0.12 sqkm/year. Source: Biribo & Woodroffe (2013)	
S_Tarawa_household_sufficiency	MIN(1, 1/(overall_household_density_in_Tarawa/INIT(overall_household_density_in_Tarawa)))		Dimensionless	Household sufficiency function represents relationship where the sufficiency decreases as the household density rises above the initial value. The sufficiency is capped at 1.	
SQ_M_TO_SQ_KM_CONVERSION	1000000		sq m / sq km	Conversion of sq m to sq km.	
SWITCH_HOUSING_LEVELS	0		Dimensionless	Switch turns on policy scenario of multi-story housing. This is turned off as most housing is currently one level.	
total_emotional_cost_of_movement_abroad	BASE_EMOTIONAL_COST_OF_MOVEMENT_ABROAD*effect_of_land_loss_on_emotional_cost		Dimensionless	The total emotional cost of movement abroad accounts for the base emotional cost and the effect that land loss may have had on it.	
total_emotional_cost_of_movement_internal	BASE_EMOTIONAL_COST_OF_MOVEMENT_INTERNAL*effect_of_land_loss_on_emotional_cost		Dimensionless	The total emotional cost of internal movement accounts for the base emotional cost and the effect that land loss may have had on it.	
y_axis	2.209161737		Dimensionless	This value was calculated through a calibration optimization of household density.	
year_reclamation_tapered	2008		year	This year was chosen as it is the last year of shoreline analysis in the latest study (Duvat, 2013).	
Utility_Functions:					

alpha_MOVING_ABROAD_FROM_KIRIBATI	0		Dimensionless	Alpha value was calculated through calibration optimisation to historic population values.	
alpha_MOVING_TO_OUTER_ISLANDS_FROM_S_TARAWA	9.349392108		Dimensionless	Alpha value was calculated through calibration optimisation to historic population values.	
alpha_MOVING_TO_S_TARAWA_FROM_OUTER_ISLANDS	0.043625133		Dimensionless	Alpha value was calculated through calibration optimisation to historic population values.	
COST_SCALING	10000		Dimensionless		
DECISION_TIME_STEP	1		year	Decision time step of 1 year set to match the evaluation time step of the model.	
FOOD_ADEQUACY_ABROAD	1		Dimensionless	The adequacy of resources and services abroad was set to 1 to represent a high comparison point.	
INFRASTRUCTURE_AND_SERVICES_PERCEPTION_ABROAD	1		Dimensionless	The adequacy of resources and services abroad was set to 1 to represent a high comparison point.	
MEDIAN_ANNUAL_PERSON_INCOME_ABROAD	45351		AUD/(people*year)	Australia data was used as a proxy for "international". The median annual personal income for migrants was $45,351 in 2019-2020. Source: https://www.abs.gov.au/media-centre/media-releases/new-migrant-jobs-and-income-data-release	
PERCEIVED_LAND_ADEQUACY	1		Dimensionless	The adequacy of resources and services abroad was set to 1 to represent a high comparison point.	
PERCEIVED_WATER_ADEQUACY_ABROAD	1		Dimensionless	The adequacy of resources and services abroad was set to 1 to represent a high comparison point.	
probability_of_moving_abroad_from_outer_islands	(EXP(utility_of_moving_abroad_from_outer_islands)//(EXP(utility_of_moving_abroad_from_outer_islands)+EXP(utility_of_moving_to_S_Tarawa)+EXP(utility_of_staying_in_outer_islands)))//DECISION_TIME_STEP		1/ year	The probability of option selection was calculated using a multinominal logit function.	
probability_of_moving_abroad_from_S_Tarawa	((EXP(utility_of_moving_abroad_from_S_Tarawa)//(EXP(utility_of_moving_abroad_from_S_Tarawa)+EXP(utility_of_staying_in_S_Tarawa)+EXP(utility_of_moving_to_the_outer_islands)))//DECISION_TIME_STEP)		1 / year	The probability of option selection was calculated using a multinominal logit function.	
probability_of_moving_to_S_Tarawa_from_outer_islands	((EXP(utility_of_moving_to_S_Tarawa)//(EXP(utility_of_moving_abroad_from_outer_islands)+EXP(utility_of_moving_to_S_Tarawa)+EXP(utility_of_staying_in_outer_islands)))//DECISION_TIME_STEP)		1 / year	The probability of option selection was calculated using a multinominal logit function.	
probability_of_moving_to_the_outer_islands_from_S_Tarawa	(EXP(utility_of_moving_to_the_outer_islands)//(EXP(utility_of_moving_abroad_from_S_Tarawa)+EXP(utility_of_staying_in_S_Tarawa)+EXP(utility_of_moving_to_the_outer_islands)))//DECISION_TIME_STEP		1/year	The probability of option selection was calculated using a multinominal logit function.	
probability_of_staying_in_outer_islands	(EXP(utility_of_staying_in_outer_islands)//(EXP(utility_of_moving_abroad_from_outer_islands)+EXP(utility_of_moving_to_S_Tarawa)+EXP(utility_of_staying_in_outer_islands)))// DECISION_TIME_STEP		1/ year	The probability of option selection was calculated using a multinominal logit function.	
probability_of_staying_in_S_Tarawa	(EXP(utility_of_staying_in_S_Tarawa)//(EXP(utility_of_moving_abroad_from_S_Tarawa)+EXP(utility_of_staying_in_S_Tarawa)+EXP(utility_of_moving_to_the_outer_islands)))//DECISION_TIME_STEP		1/ year	The probability of option selection was calculated using a multinominal logit function.	
utility_of_moving_abroad_from_outer_islands	WEIGHT_OF_INFRASTRUCTURE*LN(INFRASTRUCTURE_AND_SERVICES_PERCEPTION_ABROAD//Outer_Islands.effect_of_infrastructure_and_social_service_quality_on_outer_island_attractiveness)+ WEIGHT_OF_WATER_SECURITY*LN(PERCEIVED_WATER_ADEQUACY_ABROAD//Outer_Islands.water_adequacy_ratio)+ WEIGHT_OF_LAND_AVAILABILITY*LN(PERCEIVED_LAND_ADEQUACY//Outer_Islands.effect_of_land_loss_on_outer_island_attractiveness)+ WEIGHT_OF_FOOD_SECURITY*LN(FOOD_ADEQUACY_ABROAD//Food.total_food_stock_adequacy_Outer_Islands)+ WEIGHT_OF_FINANCIAL_SECURITY*LN(MEDIAN_ANNUAL_PERSON_INCOME_ABROAD//Outer_Islands.avg_per_capita_income_in_the_outer_islands)-Finances.total_cost_of_movement_from_Outer_Islands_abroad//COST_SCALING -alpha_MOVING_ABROAD_FROM_KIRIBATI		Dimensionless	Calculated through additive utility function with terms related to the Habitability Pillars for atolls framework where each pillar is weighted according to local prioritisation.	

utility_of_moving_abroad_from_S_Tarawa	WEIGHT_OF_INFRASTRUCTURE*LN(INFRASTRUCTURE_AND_SERVICES_PERCEPTION_ABROAD/Tarawa.S_Tarawa_household_sufficiency)+ WEIGHT_OF_WATER_SECURITY*LN(PERCEIVED_WATER_ADEQUACY_ABROAD/Water_Resources.water_adequacy_ratio)+ WEIGHT_OF_LAND_AVAILABILITY*LN(PERCEIVED_LAND_ADEQUACY/Tarawa.effect_of_land_loss_on_S_Tarawa_attractiveness)+ WEIGHT_OF_FOOD_SECURITY*LN(FOOD_ADEQUACY_ABROAD/Food.total_food_stock_adequacy_S_Tarawa)+ WEIGHT_OF_FINANCIAL_SECURITY*LN(MEDIAN_ANNUAL_PERSON_INCOME_ABROAD/Finances.income_in_S_Tarawa_per_capita)-Finances.total_cost_of_movement_from_S_Tarawa_abroad/COST_SCALING -alpha_MOVING_ABROAD_FROM_KIRIBATI		Dimensionless	Calculated through additive utility function with terms related to the Habitability Pillars for atolls framework where each pillar is weighted according to local prioritisation.	
utility_of_moving_to_S_Tarawa	WEIGHT_OF_INFRASTRUCTURE*LN(Tarawa.S_Tarawa_household_sufficiency/Outer_Islands.effect_of_infrastructure_and_social_service_quality_on_outer_island_attractiveness)+ WEIGHT_OF_WATER_SECURITY*LN(Water_Resources.water_adequacy_ratio/Outer_Islands.water_adequacy_ratio)+ WEIGHT_OF_LAND_AVAILABILITY*LN(Tarawa.effect_of_land_loss_on_S_Tarawa_attractiveness/Outer_Islands.effect_of_land_loss_on_outer_island_attractiveness)+ WEIGHT_OF_FOOD_SECURITY*LN(Food.total_food_stock_adequacy_S_Tarawa/Food.total_food_stock_adequacy_Outer_Islands)+ WEIGHT_OF_FINANCIAL_SECURITY*LN(Finances.income_in_S_Tarawa_per_capita/Outer_Islands.avg_per_capita_income_in_the_outer_islands) - Finances.total_cost_of_movement_from_Outer_Islands_to_S_Tarawa/COST_SCALING - alpha_MOVING_TO_S_TARAWA_FROM_OUTER_ISLANDS		Dimensionless	Calculated through additive utility function with terms related to the Habitability Pillars for atolls framework where each pillar is weighted according to local prioritisation.	
utility_of_moving_to_the_outer_islands	WEIGHT_OF_INFRASTRUCTURE*LN(Outer_Islands.effect_of_infrastructure_and_social_service_quality_on_outer_island_attractiveness/Tarawa.S_Tarawa_household_sufficiency)+ WEIGHT_OF_WATER_SECURITY*LN(Outer_Islands.water_adequacy_ratio/Water_Resources.water_adequacy_ratio)+ WEIGHT_OF_LAND_AVAILABILITY*LN(Outer_Islands.effect_of_land_loss_on_outer_island_attractiveness/Tarawa.effect_of_land_loss_on_S_Tarawa_attractiveness)+ WEIGHT_OF_FOOD_SECURITY*LN(Food.total_food_stock_adequacy_Outer_Islands/Food.total_food_stock_adequacy_S_Tarawa)+ WEIGHT_OF_FINANCIAL_SECURITY*LN(Outer_Islands.avg_per_capita_income_in_the_outer_islands/Finances.income_in_S_Tarawa_per_capita)- Finances.total_cost_of_movement_from_S_Tarawa_to_Outer_Islands/COST_SCALING - alpha_MOVING_TO_OUTER_ISLANDS_FROM_S_TARAWA		Dimensionless	Calculated through additive utility function with terms related to the Habitability Pillars for atolls framework where each pillar is weighted according to local prioritisation.	
utility_of_staying_in_outer_islands	WEIGHT_OF_FINANCIAL_SECURITY*LN(Outer_Islands.avg_per_capita_income_in_the_outer_islands//INIT(Outer_Islands.avg_per_capita_income_in_the_outer_islands))+ WEIGHT_OF_FOOD_SECURITY*LN(Food.total_food_stock_adequacy_Outer_Islands//INIT(Food.total_food_stock_adequacy_Outer_Islands))+ WEIGHT_OF_LAND_AVAILABILITY*LN(Outer_Islands.effect_of_land_loss_on_outer_island_attractiveness//INIT(Outer_Islands.effect_of_land_loss_on_outer_island_attractiveness))+ WEIGHT_OF_WATER_SECURITY*LN(Outer_Islands.water_adequacy_ratio//INIT(Outer_Islands.water_adequacy_ratio))+ WEIGHT_OF_INFRASTRUCTURE*LN(Outer_Islands.effect_of_infrastructure_and_social_service_quality_on_outer_island_attractivenes//INIT(Outer_Islands.effect_of_infrastructure_and_social_service_quality_on_outer_island_attractiveness))		Dimensionless	Calculated through additive utility function with terms related to the Habitability Pillars for atolls framework where each pillar is weighted according to local prioritisation.	

utility_of_staying_in_S_Tarawa	WEIGHT_OF_INFRASTRUCTURE*LN(Tarawa.S_Tarawa_household_sufficiency//INIT(Tarawa.S_Tarawa_household_sufficiency))+ WEIGHT_OF_WATER_SECURITY*LN(Water_Resources.water_adequacy_ratio//INIT(Water_Resources.water_adequacy_ratio))+ WEIGHT_OF_LAND_AVAILABILITY*LN(Tarawa.effect_of_land_loss_on_S_Tarawa_attractiveness//INIT(Tarawa.effect_of_land_loss_on_S_Tarawa_attractiveness))+ WEIGHT_OF_FOOD_SECURITY*LN(Food.total_food_stock_adequacy_S_Tarawa//INIT(Food.total_food_stock_adequacy_S_Tarawa))+ WEIGHT_OF_FINANCIAL_SECURITY*LN(Finances.income_in_S_Tarawa_per_capita//INIT(Finances.income_in_S_Tarawa_per_capita))		Dimensionless	Calculated through additive utility function with terms related to the Habitability Pillars for atolls framework where each pillar is weighted according to local prioritisation.	
WEIGHT_OF_FINANCIAL_SECURITY	0.266		Dimensionless	Polarity and strength of utility factor connections, relative to other utility factors, were found through focus group data (conducted November 2024 in South Tarawa, Kiribati). Eigenvector centrality scores were calculated for each utility factor then normalized.	
WEIGHT_OF_FOOD_SECURITY	0.226		Dimensionless	Polarity and strength of utility factor connections, relative to other utility factors, were found through focus group data (conducted November 2024 in South Tarawa, Kiribati). Eigenvector centrality scores were calculated for each utility factor then normalized.	
WEIGHT_OF_INFRASTRUCTURE	0.151		Dimensionless	Polarity and strength of utility factor connections, relative to other utility factors, were found through focus group data (conducted November 2024 in South Tarawa, Kiribati). Eigenvector centrality scores were calculated for each utility factor then normalized.	
WEIGHT_OF_LAND_AVAILABILITY	0.151		Dimensionless	Polarity and strength of utility factor connections, relative to other utility factors, were found through focus group data (conducted November 2024 in South Tarawa, Kiribati). Eigenvector centrality scores were calculated for each utility factor then normalized.	
WEIGHT_OF_WATER_SECURITY	0.206		Dimensionless	Polarity and strength of utility factor connections, relative to other utility factors, were found through focus group data (conducted November 2024 in South Tarawa, Kiribati). Eigenvector centrality scores were calculated for each utility factor then normalized.	
Finances:					
"GOVERNMENT_FUNDING_PER_CAPITA_IN_S._TARAWA"	TOTAL_GOVT_FUNDING_PER_CAPITA*DISTRIBUTION_OF_FUNDING_TO_S_TARAWA		AUD / (people*year)		
"percent_of_S._Tarawa_engaged_in_sustistence_activities"	0.041*effect_of_land_loss_on_subsistence_livelihoods		house/house	The amount of people engaged in subsistence activities will remain the same or decrease based on land loss. Sourced from "Percentage of Persons Aged 15+ by Type of Economic Activity and Island Group" (Table 2.4, pg 12). 4.1% of such people in S. Tarawa are reported to engage in subsistence economic activities.	
"total_income_in_S._Tarawa"	(INTERNATIONAL_REMITTANCES_PER_YEAR+(total_other_income*Demographics.Population_in_Tarawa)+(total_income_from_subsistence))		Australian Dollars/(Years)	Total income in South Tarawa is the combination of remittances, subsistence activity, and other income.	
ANNUAL_INCOME_FOR_SUBSISTENCE_ACTIVITY	6226		AUD / (people*year)	Sourced from "Per capita income by source and Urban/Rural" (Table 3.3, pg. 16) in the Analytical Report on the 2006 Kiribati Household Income and Expenditure Survey The total annual income for "Home Produce Sales" ($1,242,000AUD) and "Subsistence activity" ($8,782,000AUD) in S. Tarawa was $10,024,000 in 2006 (Table 3.1., pg. 13). Both of these income activities may take place on residential land.	

				The number of people in S Tarawa engaged in subsistence activity is 4.1% (Table 2.4, pg. 12). This equals 1,610 people of the 39,186 total S Tarawa population in 2006 (Table 2.1, pg. 11). Subsistence income per person engaged in subsistence activity = $10,024,000/1,610 people = $6,226/ person.	
DISTRIBUTION_OF_FUNDING_TO_S_TARAWA	0.2		Dimensionless	The proportion of budget has remained fairly constant from 2008-2018 with ~38%:20%:42% of budget to national:South Tarawa: outer islands. Sources: 2009 and 2018 National Budgets	
effect_of_land_loss_on_subsistence_livelihoods	GRAPH(Tarawa.Residential_Land_Area/(INIT(Tarawa.Residential_Land_Area))) Points: (0.000, 0.000), (0.100, 0.100), (0.200, 0.200), (0.300, 0.300), (0.400, 0.400), (0.500, 0.500), (0.600, 0.600), (0.700, 0.700), (0.800, 0.800), (0.900, 0.900), (1.000, 1.000)		Dimensionless	This converter estimates a relationship were subsistence livelihoods decrease as land is lost.	
financial_cost_to_move_abroad	15000		Dimensionless	Moving cost ($15,000 AUD) was estimated from international move website and accounts for visa, flights, shipping, and insurance. https://internationalvanlines.com/how-much-does-it-cost-to-move-to-australia/	
financial_cost_to_move_internally	300		Dimensionless	Price estimated from airline cost (~$200 AUD) from South Tarawa to Tabiteuea South with an additional $100 AUD estimated for shipping.	
GOVNT_FUNDING_PER_CAPITA_IN_OUTER_ISLANDS	TOTAL_GOVT_FUNDING_PER_CAPITA*(0.62-DISTRIBUTION_OF_FUNDING_TO_S_TARAWA)		AUD / (people* year)	Assuming ~38% of the budget will go to national programs. The funding to the outer islands will be 62 minus the percent to South Tarawa.	
income_in_S_Tarawa_per_capita	"total_income_in_S._Tarawa"/Demographics.Population_in_Tarawa		AUD/ (people* year)	Per capita income is the total income in South Tarawa divided by the population in a given year.	
INTERNATIONAL_REMITTANCES_PER_YEAR	GRAPH(TIME) Points: (1990.0, 500000), (2006.0, 6068000), (2019.0, 15477722), (2045.0, 32600000), (2063.33333333, 45600000), (2081.66666667, 61600000), (2100.0, 75000000)		AUD/ year	Points were estimated around historic data points of 2006 ($6,068,000 AUD) and 2019 ($15,477,722 AUD). These values are total remittances received for South Tarawa. Sources: 2006 and 2009 Household Income and Expenditures Report	
total_cost_of_movement_from_Outer_Islands_abroad	financial_cost_to_move_abroad+Outer_Islands.total_emotional_cost_of_movement_abroad		Dimensionless	Total cost is the sum of financial and emotional cost.	
total_cost_of_movement_from_Outer_Islands_to_S_Tarawa	financial_cost_to_move_internally+Outer_Islands.total_emotional_cost_of_movement_internal		Dimensionless	Total cost is the sum of financial and emotional cost.	
total_cost_of_movement_from_S_Tarawa_abroad	financial_cost_to_move_abroad+Tarawa.total_emotional_cost_of_movement_abroad		Dimensionless	Total cost is the sum of financial and emotional cost.	
total_cost_of_movement_from_S_Tarawa_to_Outer_Islands	financial_cost_to_move_internally+Tarawa.total_emotional_cost_of_movement_internal		Dimensionless	Total cost is the sum of financial and emotional cost.	
TOTAL_GOVT_FUNDING_PER_CAPITA	1000		AUD / (people* year)	Government funding per capita is based on total expenditure and population. It increased from ~$740/person in 2008 to ~$1,390/person in 2018. A value of $1,000 was used here.	
total_income_from_subsistence	Demographics.Population_in_Tarawa*ANNUAL_INCOME_FOR_SUBSISTENCE_ACTIVITY*"percent_of_S._Tarawa_engaged_in_sustistence_activities"		AUD/ year	The total income in South Tarawa from subsistence activities is the population times the percentage of people engaged times the per capital annual income for subsistence livelihoods.	
total_other_income	GRAPH(TIME) Points: (1990.0, 300), (1998.46153846, 800), (2006.0, 1120), (2015.38461538, 1800), (2019.0, 2032), (2032.30769231, 3300), (2040.76923077, 4100), (2049.23076923, 5100), (2057.69230769, 6300), (2066.15384615, 7600), (2074.61538462, 9000), (2083.07692308, 10300), (2091.53846154, 11800), (2100.0, 13500)		AUD/ (people* year)	Total other income for 2006 was calculated from the Per Capita total income ($1,531 AUD) minus income generated from home produce sales ($32 AUD), subsistence activity ($224 AUD), and remittances ($155 AUD) (Table 3.3, pg. 16 in Household Income and Expenditures report 2006). Total other income was calculated to be $1,120 AUD per capita in 2006. Total other income for 2019 was calculated from the total Average annual per capita income ($2,915 AUD) (Table 139, pg. 199 in Household Income and Expenditures report 2019) minus Primary industry/activities - composed of home based activities ($638 per capita per year), Cash gifts, remittances ($94 per capita per year), and Cash purchased gifts ($151 per capita per year). Total other income was calculated to be $2,032 AUD per capita in 2019.	

				Other data points were added based on research judgement.	
Food:					
ACCESS_TO_IMPORTED_FOOD_OUTER_ISLANDS	0.6		Dimensionless	Access to imported food in the outer islands is estimated to be lower than that of South Tarawa.	
ACCESS_TO_IMPORTED_FOOD_S_TARAWA	1		Dimensionless	Access to imported food is estimated to be 100% based on discussions and observations in South Tarawa.	
effect_of_temp_on_local_food_supply	GRAPH(Climate_Impacts.PROJECTED_TEMPERATURE//Climate_Impacts.HISTORIC_TEMPERATURE) Points: (1.000, 1.000), (1.100, 0.9973), (1.200, 0.9866), (1.300, 0.9451), (1.400, 0.8055), (1.500, 0.500), (1.600, 0.1945), (1.700, 0.05487), (1.800, 0.01343), (1.900, 0.002742), (2.000, 0.000)		Dimensionless	Relationship estimated from researcher and represents the idea that as temperature increases, local farming will become increasingly more difficult. Effect will be multiplied to the local food supply where a low "effect" leads to lower supply.	
imported_food_stock_Outer_Islands	REF_FOOD_SECURITY_OUTER_ISLANDS*ACCESS_TO_IMPORTED_FOOD_OUTER_ISLANDS		food stock	The imported food supply in the outer islands is calculated from a reference value for food security in the outer islands then adjusted from the estimated accessed to imported food.	
imported_food_stock_S_Tarawa	REF_FOOD_SECURITY_S_TARAWA*ACCESS_TO_IMPORTED_FOOD_S_TARAWA		food stock	The imported food supply in South Tarawa is calculated from a reference value for food security in South Tarawa then adjusted from the estimated accessed to imported food.	
local_food_supply_Outer_Islands	REF_FOOD_SECURITY_OUTER_ISLANDS*effect_of_temp_on_local_food_supply		food stock	The local food supply in the outer islands is calculated from a reference value for food security in the outer islands then dynamically updated from the effect of temperature on food production.	
local_food_supply_S_Tarawa	REF_FOOD_SECURITY_S_TARAWA*effect_of_temp_on_local_food_supply		food stock	The local food supply in South Tarawa is calculated from a reference value for food security in South Tarawa then dynamically updated from the effect of temperature on food production.	
PREFERENCE_FOR_LOCAL_FOOD_IN_OUTER_ISLANDS	0.2		Dimensionless	Averaged 'share of dietary energy consumed from own production' (Figure 6) from all regions excluding South Tarawa. [value=19.5%] FAO 'Food consumption in Kiribati'	
PREFERENCE_FOR_LOCAL_FOOD_IN_S_TARAWA	0.05		Dimensionless	From 'share of dietary energy consumed from own production' (Figure 6) for South Tarawa. [value=5%] FAO 'Food consumption in Kiribati'	
REF_FOOD_SECURITY_OUTER_ISLANDS	0.71		food stock	71% of households in the Outer Islands are classified as food secure or mildly food insecure according the the Kiribati 2019/20 Household Income and Expenditures Survey. This value was calculated from the average of all regions excluding South Tarawa. (Figure 36 of FAO Food consumption in Kiribati)	
REF_FOOD_SECURITY_S_TARAWA	0.59		food stock	59% of households in South Tarawa are classified as food secure of mildly food insecure according the the Kiribati 2019/20 Household Income and Expenditures Survey. (Figure 36 of FAO Food consumption in Kiribati)	
total_food_stock_adequacy_Outer_Islands	(1-PREFERENCE_FOR_LOCAL_FOOD_IN_OUTER_ISLANDS)*imported_food_stock_Outer_Islands+(PREFERENCE_FOR_LOCAL_FOOD_IN_OUTER_ISLANDS)*local_food_supply_Outer_Islands		food stock	The total food adequacy in the outer islands is the combination of local food and imported food availability.	
total_food_stock_adequacy_S_Tarawa	(1-PREFERENCE_FOR_LOCAL_FOOD_IN_S_TARAWA)*imported_food_stock_S_Tarawa+(PREFERENCE_FOR_LOCAL_FOOD_IN_S_TARAWA)*local_food_supply_S_Tarawa		food stock	The total food adequacy in South Tarawa is the combination of local food and imported food availability.	
Water_Resources:					
	Freshwater_Lens(t - dt) + (groundwater_recharge	INIT		Changes to the freshwater lens is based on water balance equation where change in freshwater lens storage (S) = precipitation + groundwater inflow - groundwater outflow - evapotranspiration. Runoff was not included in this calculation.	

Freshwater_Lens(t)	Freshwater_Lens(t - dt) + (groundwater_recharge - groundwater_abstractions) * dt	Freshwater_Lens = 12042762	cu m	The initial freshwater lens volume was roughly estimated from a dome equation where the diamater is the island width (1,000m) and the height is the the maximum freshwater thickness for Bonriki over a 12 year period (23m). While in reality, the freshwater lens is assymettrical, a dome shape was used for simplification. Source: Falkland & Woodroffe, 2004	
Water_in_Storage_Tanks(t)	Water_in_Storage_Tanks(t - dt) + (water_collection - tank_withdrawal) * dt	INIT Water_in_Storage_Tanks = 56375	cu m	Assuming the initial amount of water tanks in Tarawa start at half capacity. 5,245 tanks in Tarawa * 43% of population using rainwater harvesting = 2,255 tanks. 2,255 tanks (with a max of 50 cu m per tank) at half capacity = 56,375 cu meters	
Water_Tanks_in_Tarawa(t)	Water_Tanks_in_Tarawa(t - dt) + (new_tank_installations - discontinued_tank_use) * dt	INIT Water_Tanks_in_Tarawa = 2255.35	water tank	The 2005 National Census shows that 43% of households in South Tarawa use rainwater harvesting. Source: Kiribati Tarawa Water Master Plan 2010-2030 (pg 23)	
discontinued_tank_use	DELAY((Water_Tanks_in_Tarawa/LIFESPAN_OF_WATER_TANK), 30)		water tank/Years	Tank discontinuation rate is based on the lifespan of the tank.	
groundwater_abstractions	pumping_withdrawal+(INIT(Freshwater_Lens)-volume_of_lens_unaffected_by_SLR)/TIME_PERIOD_OF_LENS_VOLUME_CHANGE		cu m/year	The rate of groundwater lost from the freshwater lens is the amount from pumping in addition to the amount that is lost to salinisation.	
groundwater_recharge	MIN(effective_rainfall*AVG_RECHARGE_RATE, volume_that_can_infiltrate/TIME_PERIOD_OF_LENS_VOLUME_CHANGE)		cu m/year	Recharge rate = preciptation - evapotranspiration +/- the change in soil-moisture store. This calculation assumes soil-moisture store to be constant and only includes precipitation and evapotranspiration. Source: Falkland & Woodroffe, 2004 This is currently assuming that all rainwater that hits non-developed land is soak into the ground for groundwater (no runoff). This is supported by Post et al., 2018 who say that runoff can be "neglected because of the high infiltration capacity of the soils, the flat topography, and the lack of surface flow feature on the island." This is agreed by White (1996) who gives simplified water balance equation, where no soil hydrology needed.	
new_tank_installations	tank_installation_from_new_housing+new_tanks_funded_by_govt+tank_replacement_rate		water tank/Years	New tank installation rates are based primarily on a constant tank replacement rate to replace discontinued tanks and tank installations from new housing. When the government funding/ tank subsidy switch is on, new tanks can also be added from that.	
tank_withdrawal	rainwater_usage		cu m / year	The rate of water withdrawal from tanks is from the usage.	
water_collection	MIN(supply_from_house_catchment, volume_that_can_be_collected)*RAINWATER_HARVESTING_SWITCH		cu m/year	The rate of water collection is based on the rainwater able to be collected from a roof surface area, but limited by the amount of tank capacity (or vice versa).	
ADDITIONAL_WATER_CONSUMPTION_NEED_PER_CAPITA_PER_DEG_WARMING	2		liter / (people*day*Degrees C)	Estimate taken from Kiribati Tarawa Water Master Plan 2010-2030 (Section 5.2). The projection in the Master Plan was for 1deg C of warming by 2020 and allowed an additional 2L/person/day in demand. Using this, we estimate an increased demand of 2L/person/day for every 1degC of warming.	
AVG_RECHARGE_RATE	0.36		Dimensionless	From historical rainfall and recharge data, Falkland & Woodroffe calculated an average recharge rate of 36% of rainfall. Source: Falkland & Woodroffe, 2004	

BONRIKI_LAND_AREA	9.5		sq km	The area of Bonriki was used before it is the surface area that infiltrates down into the main freshwater lens used for pumping. The water pumped from this area by the public utilities (PUB) supplies 67% of South Tarawa's population. Source: Post et al., 2018	
CONVERSION_MM_TO_M	0.001		m / mm	Conversion of mm to m.	
CONVERSION_SQ_KM_TO_SQ_M	1000000		sq m/ sq km	Conversion of sq km to sq m	
COST_OF_WATER_TANK	1313		Australian Dollars / water tank	Price sourced from tank retailer at $850USD ($1313AUD) for a 1000 gallon tank. Price conversion from USD to AUD made on Apr. 15, 2024. Source: https://tankretailer.com/products/quadel-plastic-water-storage-tank?currency=USD&variant=47211282399552&utm_medium=cpc&utm_source=google&utm_campaign=Google+Shopping&stkn=6c7cd00f44c4&srsltid=AfmBOoq-36JVc4XSGgwntd93qvIaG__KDGwdEUOIhZ6M4zAwkB-bQ2f-VRE&com_cvv=d30042528f072ba8a22b19c81250437cd47a2f30330f0ed03551c4efdaf3409e	
DAY_TO_YEAR_CONVERSION	365		day / year	Conversion of day to year	
DESAL_SWITCH	0		Dimensionless	Switch turns on scenario for the use of desalination plants. Currently set at 0 as none of the proposed plants are currently in use.	
DESALINATION_PLANT_PROPOSED_WATER_PUMPING_RATES_PER_DAY	3000		cu m / (plants *day)	The Environmental and Social Impact Assessment for the 2 proposed desalination plants estimates an additional 6,000 cu m/ day of water supply. It is assumed that each plant will contribute 3,000 cu m/day. Source: Kiribati: South Tarawa Water Supply Project (ADB, 2020)	
desalination_water_usage	IF TIME < 2024 THEN 0 ELSE MIN(DESALINATION_PLANT_PROPOSED_WATER_PUMPING_RATES_PER_DAY*NUMBER_OF_DESAL_PLANTS*DAY_TO_YEAR_CONVERSION, total_water_demand_yearly)*DESAL_SWITCH		cu m / year		
effect_of_rainwater_scarcity_on_consumption	GRAPH(IF rainwater_need > 0 THEN (Water_in_Storage_Tanks/rainwater_need) ELSE 1) Points: (0.000, 0.2000), (0.100, 0.2357), (0.200, 0.2775), (0.300, 0.3264), (0.400, 0.3836), (0.500, 0.4506), (0.600, 0.5289), (0.700, 0.6206), (0.800, 0.7278), (0.900, 0.8532), (1.000, 1.0000)		Dimensionless	This relationship represents a behaviour where rainwater tank water is used freely if tanks are full. The use of rainwater becomes more measured if the amount in the tanks is perceived to be inadequate to the usage need. A minimum value was set to indicate that rainwater usage would still continue, even if minimally, at low tank supply.	
EFFECT_OF_SEA_LEVEL_RISE_ON_SALINITY	100		m/ (m)	Sherif and Singh (1999) and Werner & Simmons (2009) both found that there may be toe migration "on the order of 5km inland for a 500-mm sea level rise". This assumed a constant head, compared to a constant flux conditions which would be around 50 meters. A rate of 5000meters/ 0.5 meters seems too high after testing. Value lowered to 50meters/0.5meters. Source: Werner&Simmons (2009) Constant head conditions were assumed because water table levels stay relatively constant ("at typical depths of about 1-2 m below groundlevel". Source: Falkland &Woodroffe (2004)	
effective_rainfall	IF TIME < 2023 THEN (Climate_Impacts.HISTORIC_RAINFALL-evapotranspiration_rate)*BONRIKI_LAND_AREA*CONVERSION_MM_TO_M*CONVERSION_SQ_KM_TO_SQ_M ELSE (Climate_Impacts.PROJECTED_RAINFALL-evapotranspiration_rate)*BONRIKI_LAND_AREA*CONVERSION_MM_TO_M*CONVERSION_SQ_KM_TO_SQ_M		cu m/ year		

evapotranspiration_rate	IF TIME< 2023 THEN 17.162*LN(Climate_Impacts.HISTORIC_RAINFALL)+26.1 ELSE 17.162*LN(Climate_Impacts.PROJECTED_RAINFALL)+26.1		mm/year	Actual annual evapotranspiration rates (mm) were plotted against month precipitation (mm) in Kiribati using values from 'Table 19-4. Water-balance calculations for 1989-1990, Tarawa.' Data was fit with a logarithmic trend line to determine the equation of y= 17.162ln(x)+26.1 Water-balance calculations found annual evapotranspiration rates to be higher in wet years than dry years. Source: Falkland & Woodroffe 2004	
freshwater_lens_width	1000-inland_migration_of_lens_from_SLR		m	Initial island width was estimated at 1,000m (Falkland & Woodroffe, 2004). Updated island width is initial width minus the width of the freshwater lens lost to sea level rise.	
GOVT_FUNDING_SWITCH	0		Dimensionless	Switch turns on scenario for testing government funding.	
inland_migration_of_lens_from_SLR	Climate_Impacts.sea_level_rise*EFFECT_OF_SEA_LEVEL_RISE_ON_SALINITY		m	The inland migration of freshwater lens is calculated from the projected sea level rise and the effect relationship between horizontal distance to vertical sea rise.	
LENS_THICKNESS	23		m		
LIFESPAN_OF_WATER_TANK	30		year	Based on average lifespan for polyethylene tanks. Source: https://smartwateronline.com/news/how-long-will-my-water-tank-last#:~:text=Summary,well%20maintained%20and%20well%2Dpositioned.	
LITER_TO_CU_M_CONVERSION	1000		liter / cu m	Conversion of liter to cubic meter	
MIN_DAILY_WATER_CONSUMPTION_NEEDED	65		liter / (people *day)	Water consumption is estimated at 65L/ person/day. Source: Kiribati Tarawa Water Master Plan 2010-2030 (pg 24)	
new_tanks_funded_by_govt	(Finances."GOVERNMENT_FUNDING_PER_CAPITA_IN_S._TARAWA"*Demographics.Population_in_Tarawa)*PERCENT_OF_BUDGET_ON_WATER_INFRASTRUCTURE*PERCENT_CONVERSION/COST_OF_WATER_TANK*GOVT_FUNDING_SWITCH		water tank/ year		
NUMBER_OF_DESAL_PLANTS	3		plants	There are currently 3 proposed desalination plants in South Tarawa.	
PERCENT_CONVERSION	0.01		Dimensionless	Conversion of percent to decimal value.	
PERCENT_OF_BUDGET_ON_WATER_INFRASTRUCTURE	0.6		Dimensionless	Estimated from percent of Infrastructure budget in the Ministry of Public Works and Utilities ($4,652,123AUD) vs the total budget for 2008 ($81,881,605). $500,000 of this was estimated towards rainwater tanks. Source: National Budget 2009 (pg 67) Value is 0.006 (0.6%)	
PERCENT_OF_NEW_HOUSES_USING_RAINWATER	1		Dimensionless	This value was calculated through a calibration optimization. COME BACK TO THIS NUMBER.	

pumping_withdrawal	MIN((groundwater_recharge*RECHARGE_ABSTRACTION_PERCENT), MAX(0, (total_water_demand_yearly-desalination_water_usage-rainwater_usage)))		cu m/ year	Water supply will first prioritise desalination plant supply then use groundwater and rainwater if more is needed. The pumping is also affected by the preference between rainwater harvesting and groundwater pumping. The pumping will compensate past the rainwater/groundwater preference if rainwater cannot achieve the set preference ratio. The abstraction rate is limited by the recommendation that only 25-50% of the recharge volume be abstracted.	
RAINWATER_HARVESTING_SWITCH	1		Dimensionless	Switch turns on scenario for the use of rainwater harvesting.	
rainwater_need	(total_water_demand_yearly-desalination_water_usage)*rainwater_preference_to_groundwater		cu m / year	This variable is used to indicate is rainwater harvesting will be used. If yes, then consumption behaviour will be adjusted.	
rainwater_preference_to_groundwater	0.5		Dimensionless	The preference value between rainwater harvesting and groundwater pumping is set to 50:50.	
rainwater_usage	MAX(0, rainwater_need *effect_of_rainwater_scarcity_on_consumption)		cu m/ year	Water supply will first prioritise desalination plant supply then use groundwater and rainwater if more is needed. The rainwater usage is also affected by the preference between rainwater harvesting and groundwater pumping.	
RECHARGE_ABSTRACTION_PERCENT	0.5		Dimensionless	In order to maintain the integrity of the freshwater lens, only 25-50% of the recharge amount should be withdrawn. Source: Management of freshwater lenses on small Pacific islands (White & Falkland, 2009)	
ROOF_AREA	140		sq m / housing building	The average roof area (140 sq m) from housing types in Kiribati was used. Source: Foon et al., 2006	
supply_from_house_catchment	IF TIME<2023 THEN (LOOKUP(Climate_Impacts.HISTORIC_RAINFALL, TIME)*Tarawa.Housing_Units*ROOF_AREA/2*CONVERSION_MM_TO_M/(Tarawa.HOUSING_LEVELS)) ELSE(Climate_Impacts.PROJECTED_RAINFALL*Tarawa.Housing_Units*ROOF_AREA/2*CONVERSION_MM_TO_M/(Tarawa.HOUSING_LEVELS))		cubic meter / year	From t=0 until 2020, the volume will be calculated from the historic rainfall amount multiplied by the catchment area. The catchment area is assumed to be half of the house footprint. For future projections, the volume is calculated from projected rainfall (based on RCPs) multiplied by the catchment area. The catchment area is assumed to be half of the house footprint.	
TANK_EVALUTION_TIME	1		year	A tank evaluation time of 1 year was chosen to match the interval of rainfall data to make sure that more rainfall is not being collected than available.	
tank_installation_from_new_housing	Tarawa.housing_development/ (IF Tarawa.SWITCH_HOUSING_LEVELS = 1 THEN Tarawa.HOUSING_LEVELS ELSE 1) *WATER_TANK_PER_HOUSE_FOOTPRINT*PERCENT_OF_NEW_HOUSES_USING_RAINWATER		water tank/ year	The number of tanks installed from new builds is calculated from the percent of new houses using rainwater harvesting of the new housing units developed (divided by levels if multi-story switch is on). Each new housing build can have a certain number of tanks, based on the 'Water tank per house footprint' variable.	
tank_replacement_rate	10		water tank/ year		
TANK_VOLUME	50		cu m/ (water tank)	A tank volume of 50 cu meters is used from Foon et al. (2006) who advises that this is the maximum size which a normal household can afford.	
TIME_PERIOD_OF_LENS_VOLUME_CHANGE	1		year	Period of change was selected to match the rainfall data and other model evaluation increments.	
total_additional_water_needed_from_temperature_increase	ADDITIONAL_WATER_CONSUMPTION_NEED_PER_CAPITA_PER_DEG_WARMING*Climate_Impacts.degree_of_warming		liter / (people* day)	Total additional water needed from temperature increase is calculated from the projected temperature increase and the relationship between temperature and water need increase.	
total_capacity_of_tanks	Water_Tanks_in_Tarawa*TANK_VOLUME		cu m	Total capacity of rainwater tanks in South Tarawa is calculated from the total number of tanks and their volume.	
total_water_demand_yearly	((MIN_DAILY_WATER_CONSUMPTION_NEEDED+total_additional_water_needed_from_temperature_increase)*Demographics.Population_in_Tarawa)*DAY_TO_YEAR_CONVERSION/LITER_TO_CU_M_CONVERSION		cu m / year	The total yearly water demand for South Tarawa is based on the minimum water needed per person, adjusted to increase with temperature, and dynamically updated with population changes.	

volume_of_lens_unaffected_by_SLR	(2/3)*PI*(freshwater_lens_width/2)^2*LENS_THICKNESS		cu m	The freshwater lens volume was roughly estimated from a dome equation where the diameter is the island width ('freshwater lens width' converter) and the height is the the maximum freshwater thickness for Bonriki over a 12 year period (23m). While in reality, the freshwater lens is assymettrical, a dome shape was used for simplification. A static value of lens thickness was also assumed. Source: Falkland & Woodroffe, 2004	
volume_that_can_be_collected	MAX(0, (total_capacity_of_tanks-Water_in_Storage_Tanks)/TANK_EVALUTION_TIME)		cu m/ year	The total volume of water that can be in the tanks is calculated from the total capacity minus the amount of water that is already in the tanks. Max function ensures that it can't go below 0.	
volume_that_can_infiltrate	MAX(0, volume_of_lens_unaffected_by_SLR-Freshwater_Lens)		cu m	The volume that can be infiltrated (filled) is the total capacity minus the volume of water that is already in there.	
water_adequacy_ratio	(total_water_demand_yearly-water_demand_deficit)/ total_water_demand_yearly		Dimensionless		
water_demand_deficit	MAX(0, total_water_demand_yearly-desalination_water_usage-rainwater_usage-pumping_withdrawal)		cu m / year		
WATER_TANK_PER_HOUSE_FOOTPRINT	2		water tank/ housing building	Each house is assumed to have the ability to accommodate up to two water tanks.	

Run Specs	
Start Time	1990
Stop Time	2100
DT	1
Fractional DT	TRUE
Save Interval	1
Sim Duration	1.5
Time Units	Years
Pause Interval	0
Integration Method	Euler
Keep all variable results	TRUE
Run By	Run
Calculate loop dominance information	TRUE
Exhaustive Search Threshold	1000

Custom Unit	Aliases	Equation
Dimensionless	dmnl unitless	1