STANDARD & POOR'S
RATINGS SERVICES
McGRAW HILL FINANCIAL

RatingsDirect®

Climate Change Is A Global Mega-Trend For Sovereign Risk

Primary Credit Analyst:
Moritz Kraemer, Frankfurt (49) 69-33-999-249; moritz.kraemer@standardandpoors.com

Secondary Contact:
Liliana Negrila, Frankfurt +49 69 33 999-248; liliana.negrila@standardandpoors.com

Table Of Contents

Climate Change Is A Global Mega-Trend For Sovereign Risk

*(**Editor's Note:** The article published earlier today contained incorrect calculations in our vulnerability index. A corrected version follows.)*

Since the turn of the century, two mega-trends have emerged to dominate public discussion on global economic risks. The first, global aging, is comparatively well-understood and the consequences relatively clear. The second, the impact of climate change, is far hazier and the potential outcomes much more challenging to predict.

For over a decade Standard & Poor's Ratings Services has been regularly assessing the impact that demographic change is likely to have on sovereign creditworthiness. Our conclusion is that over a multi-decade time horizon the financial consequences of aging societies are likely to overshadow all other economic trends for most sovereigns (see "Global Aging 2013: Rising To The Challenge" March 20, 2013). We also expect advanced economies will be more negatively affected than sovereigns in emerging markets. In contrast, while most sovereigns will feel the negative effects of climate change to some degree, we expect the poorest and lowest rated sovereigns will bear the brunt of the impact. This is in part due to their reliance on agricultural production and employment, which can be vulnerable to shifting climate patterns and extreme weather events, but also due to their weaker capacity to absorb the financial cost.

Overview

- Climate change is likely to be one of the global mega-trends impacting sovereign creditworthiness, in most cases negatively.
- The impact on creditworthiness will probably be felt through various channels, including economic growth, external performance, and public finances.
- Sovereigns will probably be unevenly affected by climate change, with poorer and lower rated sovereigns typically hit hardest, which could contribute to rising global rating inequality.

Another key difference is time frame. The impact of aging societies is already being felt in several advanced economies, most notably Japan, and will steadily increase through the next few decades. For most sovereigns, their demographic profile is such that the full impact of aging on economic performance and public finances will be felt from the mid-2020s or soon after (note: this is well beyond the time-horizon that can be reasonably applied to a sovereign credit rating). Our understanding of climate change, on the other hand, is still developing and we lack sufficient reliable data to make precise predictions on if and when the effects of a warming planet and changing weather patterns will overshadow other factors. This does not imply we should be complacent in developing a clearer view, however. By its very nature of complex and inter-connected ecological systems, weather is inherently unpredictable and the picture can change suddenly and dramatically for an individual country or region.

Climate Change Is More Difficult To Control Than Demographic Change

We believe that alongside aging, climate change, and specifically global warming, is going to be the second global mega-trend affecting sovereign credit risk. We also believe that it will put downward pressure on sovereign ratings during the remainder of this century. However, in our view there are three noteworthy differences that may make climate change an even more challenging problem to grasp than the world's shifting demographic.

1. The science is complex.

The economic and financial consequences are much less-well understood than those of aging societies. There remains significant uncertainty about how climate change will impact individual national territories and economies. For example, the fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC) published in 2013 estimates that the average winter temperature in Northern Europe could rise between +2°C to +7°C by 2100. But there is also a chance that the warming in winter will remain within the bounds of a standard deviation of present-day natural variability. Not so in summer, however, where the IPCC estimates that warming is all but unavoidable.

The wide array of possible outcomes can confuse politicians and voters alike and can lead to procrastination and inaction. Even in the case of aging, where financial consequences are generally well-studied and documented, we have seen that remedial action has in most countries been slow and difficult. This is usually because the benefits lie in the distant future whereas some of the unpopular consequences are being felt immediately, conspiring against robust action, especially in societies where leaders need to renew their legitimacy regularly through elections. In addition, as many of the beneficiaries do not yet have a political voice, either because they are too young to vote or they have not been born yet. While this argument can be made equally about the difficulty of enacting measures that might curb greenhouse gas emissions, the political impasse is exacerbated by the much higher uncertainty about future climatic conditions.

2. A global, collective action problem.

The degree to which individual countries and societies are going to be affected by warming and changing weather patterns depends largely on actions undertaken by other, often far-away societies. Unlike in the case of aging, individual societies cannot by themselves meaningfully reduce the impact they will feel as the climate changes. This is the global collective action problem that has been characterizing climate negotiations ever since the seminal Rio summit in 1992. A society may choose to reduce its carbon emissions unilaterally to reduce the risk of the potential consequences of global warming, but due to the global character most of the benefits of that society's sacrifice will accrue to other nations. In game theory, this is the famous prisoner's dilemma: each society would be worse off if it were to act alone to mitigate climate change: the society would have all the pain for negligible gain. On the other hand it would be better-off if it shirked an international concerted mitigation effort that all other societies undertook: the society would have to take no sacrifice while it benefits from the improvements caused by the actions of others. Typically such an incentive structure leads to uncooperative outcomes and to no effective risk mitigation. This is fundamentally different from tackling the aging challenge: a pension reform, for example, will accrue to the society that enacts it and to that society alone. The spillover benefits for other countries are negligible.

3. The impact falls disproportionately on poorer countries.

Despite the complex and sometimes controversial science underlying estimates of global warming, we believe that poorer and generally lower rated sovereigns will be disproportionately hit (see below). In contrast, the aging problem is expected to impact highly rated sovereigns more than those with lower ratings. Our aging simulations suggest that in a no-action scenario, the net general government debt ratio of the advanced economies will rise by 150 percentage points between 2010 and 2050 to reach 216% of GDP. Emerging market sovereigns will experience an average increase of just under 120% points to reach a net general government debt ratio of 149%. In other words, the sovereigns that should be best able to address the aging challenge are hit by it more than proportionately. The opposite is likely to be true in the case of climate change. The most affected can be expected to be poorer and to have less clout in international negotiations, exacerbating the international coordination problem described above.

How Climate Change Can Impact Sovereign Ratings

Extreme weather events, such as tropical storms or floods, seem to have been on the rise since the early 1980s. Data collected by MunichRe, a reinsurer, suggest that weather-related loss-events have risen in all continents, most significantly in Asia and North America, where they increased more than fourfold. In Eastern Asia overall losses (insured and non-insured) used to be below $10 billion per year, but have regularly surpassed $20 billion during the last decade with a peak of over $50 billion (1). Typhoon Haiyan hitting The Philippines in November 2013 has been a powerful and hugely destructive reminder of this trend.

Despite the grave loss of life and the devastation caused by extreme weather events, Standard & Poor's has not revised the rating of a sovereign as a consequence. We have taken a view that the size of the devastation, while large in absolute terms, has so far not been sufficient to impact the rating overall. However, assuming that extreme weather events are on the rise in terms of frequency and destruction, how this trend could feed through to our ratings on sovereign states bears consideration.

We analyse sovereigns applying our ratings methodology ("Sovereign Government Rating Methodology And Assumptions" June 24, 2013). This incorporates the specific assessment of five key factors: institutional and governance effectiveness, economic structure and growth prospects, external liquidity and international investment position, fiscal performance and flexibility, and monetary flexibility. Unless environmental disasters undermine national institutions and governance to an unprecedented degree (e.g. through massive population migration or political instability), we believe that the main factors through which climate change could feed through to sovereign creditworthiness are economic, fiscal, and external performance.

Economic performance.

There are multiple channels through which climate change can affect the growth prospects of national economies and eventually levels of prosperity. Some of the most potent may be changing patterns of rainfall that can reduce agricultural yields via repeated and prolonged droughts, heat waves and wildfires, or floods. The productivity of the broader workforce could also be negatively impacted if weather events affect sanitary conditions negatively, spreading pests or diseases, increasing morbidity. This may become a particular burden for populations living in low areas close to sea-level, where rising sea-levels in the context of global warming will not only flood agricultural and densely

populated urban areas, but where a rising water table could lead to salinization of the population's water supply.

Extreme weather events, especially floods, can be expected to increasingly take a toll on a country's infrastructure and thus productivity, exacerbating weakening endowment of productive infrastructure observable in a number of countries (see "Cracks Appear In Advanced Economies' Government Infrastructure Spending As Public Finances Weaken", Jan. 14, 2014). The most direct and tragic economic cost is of course the loss of life, such as the more than 6,000 deaths estimated in the Philippines in the aftermath of typhoon Haiyan. In China, an average 3,000 flood-related deaths are estimated to have occurred each year since 1980. During the 1990s, Flood losses oscillated to 2% of Chinese GDP per year, before dropping to below 1% as a consequence of enhanced flood management (2).

How climate change will impact GDP growth is highly uncertain. Some research estimates the annual consumption loss in 2100 as a fraction of global GDP would be around 2%, but jump to well over 5% should the annual global temperature rise twice as fast as in the current scientific baseline scenario (3). The estimates for specific regions or even countries are even more variable, as the IPCC's "Atlas of Global and Regional Climate Projections" illustrates. But the evidence suggests that it is probably safe to expect that for most national economies, other things being equal, climate change will negatively impact national welfare and economic growth potential. Observations corroborating this expectation could lead Standard & Poor's to lower sovereign ratings on the most affected sovereigns.

Fiscal performance.

The potential negative impact on growth will by itself weigh on public finances as tax revenues are likely to lose buoyancy if the underlying national economy falters. Government budgets could come under additional pressure as disaster recovery and emergency support for affected populations is likely to fall on the state in most cases. The same can be expected for the reconstruction of economic and social infrastructure. This can be a large burden for the public budget and, contrary to the fiscal impact from aging societies, it can hit the budget without much prior notice. An extreme example of a natural disaster (although not weather-related) overwhelming the government's financial capabilities has been the violent volcanic eruption on the small Caribbean island of Montserrat in July 1995, which rendered half of the island uninhabitable. The island, being an overseas territory of the U.K., was able to cope due to extremely significant foreign grants, which continue to contribute roughly half of its GDP for budget support and infrastructure investment (see: Montserrat, Nov. 8, 2013). Larger economies would not be able to count on external support on the same scale, especially if climate-related fiscal pressures were to increase in many countries simultaneously. National budgets would invariably come under additional strains, potentially putting downward pressure on sovereign ratings as debts and deficits mount.

External performance.

Some nations depend on exports of agricultural products for foreign currency. With erratic weather patterns or increasingly frequent droughts or floods undermining the export base, the adequacy of foreign reserves may become threatened as trade imbalances rise. Of course national currencies could depreciate to an extent to recalibrate imports and exports, but this would in many cases come at the price of rising inflation and falling levels of prosperity. Should episodes of bad harvests increase, emergency food imports may be required, once again putting pressure on the country's external accounts. Should global food production stagnate as climate conditions change, prices for agricultural goods would permanently increase. Terms of trade of net food importers would worsen, putting pressure on their external accounts, which in turn could increase the downside risks for sovereign ratings.

Lower-Rated Sovereigns Appear More Exposed

Great uncertainty still remains about if, how, and when various economies could be affected by climate change. Nevertheless, there are various ways through which we can attempt to gauge the vulnerability of individual sovereigns. While there is no single best measure to measure the degree to which various economies are exposed to the risks, we can use a composite of three different variables to capture different facets of potential vulnerability and arrive at a crude ranking:

1. Share of the population living in coastal areas below five meters of altitude. The livelihood and economic production of that population may be at risk should sea levels rise in the course of global warming (World Bank, World Development Indicators).

2. Share of agriculture in national GDP. This measures the risk to the sector that is typically most dependent on climatic conditions. (World Bank, World Development Indicators, Food And Agriculture Organization Of The United Nations Statistical Yearbook 2012)

3. The vulnerability index compiled by Notre Dame University Global Adaptation Index (ND-GAIN), which measures the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change. The index includes three components: exposure, sensitivity and adaptive capacity (http://index.gain.org/ranking).

For each of the three variables, we rank the 116 rated sovereigns for which all three variables are available. A rank number of 1 indicates lowest vulnerability, a rank of 116 the highest. Finally, we assign an overall rank of vulnerability which is derived by ranking the sum of the three ranks for each of the three indicators. For example, the average of the three variable-specific ranks of Cambodia is 103. This is the highest average rank number of any of the rated sovereigns included. Therefore, we assign Cambodia the highest possible overall rank of 116, being the most vulnerable to climate change by this measure, followed by Vietnam, Bangladesh, and Senegal.

Table 1

Vulnerability To Climate Change

Overall ranking	Sovereign	Population living below five meters altitude (2000)		Agriculture as share of GDP (2012)		GAIN Vulnerability Index (2012)	
		Rank	(%)	Rank	(%)	Rank	Index
116	Cambodia	90	10.6	113	35.6	106	0.500
115	Vietnam	112	42.8	103	19.7	90	0.381
114	Bangladesh	98	14.0	100	17.7	104	0.495
113	Senegal	100	14.8	96	16.7	100	0.472
112	Mozambique	71	6.5	109	30.3	109	0.513
111	Fiji	91	11.0	91	13.2	97	0.422
110	Philippines	89	10.5	87	11.8	91	0.382
109	Nigeria	46	3.0	111	33.1	108	0.503
108	Papua New Guinea	35	2.0	114	35.9	107	0.502
106	Indonesia	92	11.2	92	14.4	70	0.335
106	Suriname	116	68.2	77	9.3	61	0.306

Table 1

Vulnerability To Climate Change (cont.)							
105	Ethiopia	22	0.4	116	46.4	115	0.547
103	Albania	81	8.2	101	18.3	68	0.333
103	Kenya	29	1.4	108	29.9	113	0.530
101	Congo (Democratic Republic of)	17	0.0	115	44.9	116	0.572
101	India	51	3.8	99	17.5	98	0.427
100	Egypt	110	25.6	93	14.5	44	0.284
99	Thailand	96	13.8	88	12.3	62	0.308
97	Ghana	39	2.3	105	22.7	101	0.473
97	Grenada	105	21.7	57	5.7	83	0.355
96	Cape Verde	97	13.8	69	7.8	78	0.349
95	Belize	102	15.8	90	13.1	50	0.293
94	Pakistan	27	1.3	106	24.4	99	0.430
92	Malaysia	86	9.5	81	10.1	63	0.310
92	Morocco	50	3.8	94	14.6	86	0.365
91	Honduras	38	2.2	95	14.8	95	0.402
90	Burkina Faso	1	0.0	112	35.3	114	0.533
88	Angola	36	2.1	80	10.0	110	0.516
88	Cameroon	20	0.3	104	19.7	102	0.474
87	Lebanon	84	9.1	61	6.1	80	0.350
86	Rwanda	1	0.0	110	33.0	111	0.521
85	Uganda	1	0.0	107	25.9	112	0.522
82	China	80	8.1	82	10.1	57	0.303
82	Ecuador	76	7.3	79	9.9	64	0.316
82	Jamaica	68	5.8	66	6.7	85	0.362
80	Azerbaijan	111	29.8	56	5.5	50	0.293
80	The Bahamas	113	46.5	27	2.1	77	0.348
79	Sri Lanka	66	5.4	83	11.1	67	0.332
78	El Salvador	33	1.7	86	11.8	92	0.384
77	Zambia	1	0.0	102	19.6	105	0.497
76	Gabon	69	5.9	50	3.9	83	0.355
74	Barbados	101	15.7	17	1.5	81	0.352
74	Latvia	109	23.9	51	4.1	39	0.263
73	Dominican Republic	45	3.0	60	6.1	93	0.399
72	New Zealand	94	12.6	65	6.6	36	0.259
71	Mongolia	1	0.0	97	17.1	93	0.399
70	Iceland	95	13.1	68	7.3	27	0.236
69	Bahrain	115	66.6	3	0.0	71	0.339
68	Peru	32	1.7	67	7.0	88	0.370
67	Guatemala	21	0.3	85	11.6	78	0.349
66	Bolivia	1	0.0	89	13.0	89	0.378
65	Georgia	47	3.3	72	8.5	59	0.304

Table 1

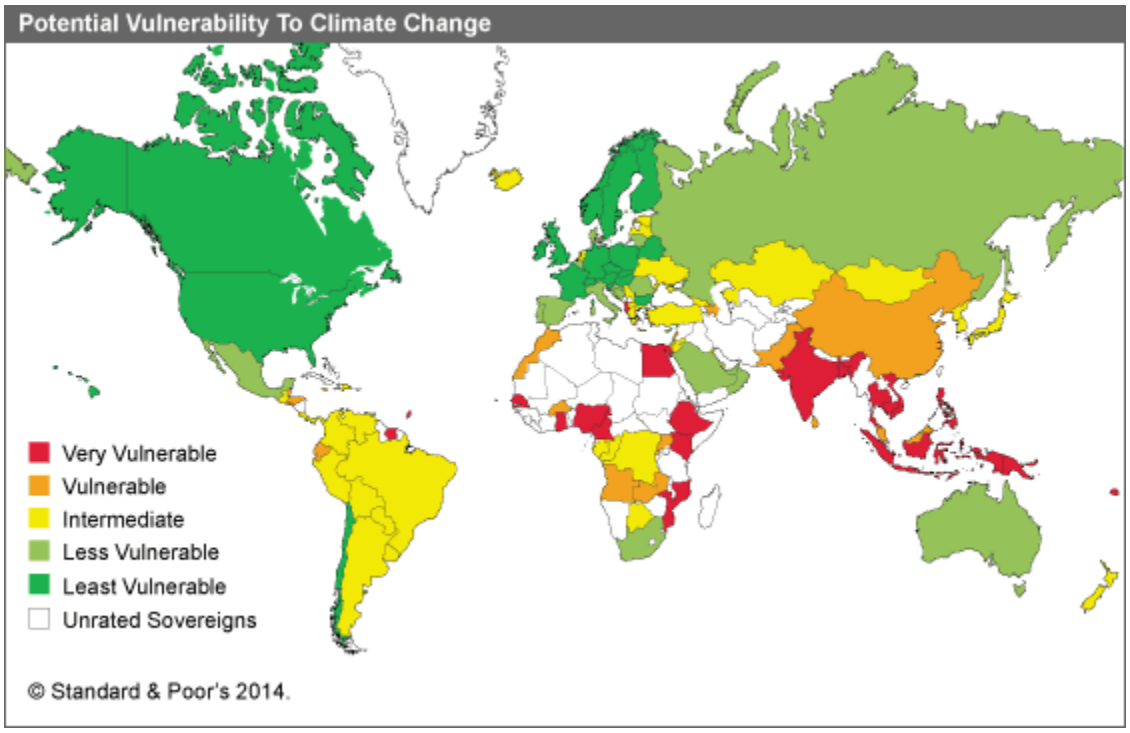
Vulnerability To Climate Change (cont.)							
62	Korea, Rep.	64	5.0	36	2.6	76	0.347
62	Kuwait	107	22.8	4	0.1	65	0.321
62	Singapore	93	12.1	2	0.0	81	0.352
61	Paraguay	1	0.0	98	17.4	75	0.345
58	Argentina	61	4.5	75	9.1	37	0.262
58	Panama	53	4.0	49	3.9	71	0.339
58	Uruguay	62	4.7	70	8.4	41	0.274
57	Brazil	63	4.9	55	5.2	53	0.296
56	Congo (Democratic Republic of)	25	1.0	41	3.4	103	0.489
55	Japan	103	16.2	13	1.2	48	0.290
54	Malta	106	21.8	23	1.9	33	0.256
52	Qatar	108	23.1	1	0.0	52	0.294
52	Serbia	19	0.1	73	9.0	69	0.334
51	Costa Rica	24	0.8	62	6.3	74	0.343
49	Estonia	74	7.2	52	4.1	31	0.253
49	Greece	88	9.9	40	3.4	29	0.246
47	Jordan	58	4.2	39	3.1	59	0.304
47	Turkey	40	2.4	74	9.1	42	0.277
46	Venezuela	49	3.7	58	5.8	46	0.285
45	Colombia	34	2.0	64	6.5	54	0.298
44	Ukraine	37	2.1	76	9.3	37	0.262
41	Israel	82	8.3	34	2.5	33	0.256
41	Kazakhstan	52	3.9	53	4.7	44	0.284
41	Netherlands	114	61.3	22	1.7	13	0.191
40	South Africa	23	0.5	35	2.6	87	0.366
39	Oman	67	5.5	12	1.0	65	0.321
38	Macedonia	1	0.0	84	11.5	57	0.303
36	Trinidad and Tobago	78	7.5	6	0.6	56	0.302
36	United Arab Emirates	77	7.3	9	0.7	54	0.298
35	Russian Federation	43	2.9	48	3.9	47	0.289
34	Cyprus	87	9.7	26	2.1	24	0.227
32	Botswana	1	0.0	38	2.9	96	0.421
32	Mexico	42	2.7	45	3.6	48	0.290
31	Australia	75	7.2	31	2.4	28	0.239
30	Romania	44	2.9	59	6.0	30	0.251
29	Lithuania	55	4.0	42	3.5	35	0.257
28	Bosnia and Herzegovina	18	0.1	71	8.4	40	0.272
26	Saudi Arabia	26	1.0	28	2.2	73	0.341
26	Spain	72	6.6	33	2.5	22	0.214
24	Belgium	99	14.3	10	0.7	17	0.205
24	Portugal	65	5.2	29	2.3	32	0.255

Table 1

Vulnerability To Climate Change (cont.)							
23	Italy	79	7.5	25	2.0	21	0.212
22	Denmark	104	18.5	16	1.4	2	0.145
21	Croatia	48	3.4	54	5.0	19	0.207
20	Chile	31	1.6	46	3.6	43	0.282
19	Bulgaria	30	1.5	63	6.4	23	0.223
18	Finland	59	4.4	37	2.7	12	0.189
16	Ireland	73	6.6	19	1.6	14	0.194
16	Norway	85	9.3	14	1.2	7	0.162
15	Sweden	70	6.3	18	1.6	17	0.205
14	Belarus	1	0.0	78	9.7	25	0.230
13	Canada	54	4.0	21	1.6	26	0.234
12	U.K.	83	8.6	7	0.7	8	0.165
10	Poland	41	2.5	44	3.5	3	0.150
10	U.S.	57	4.1	15	1.2	16	0.199
9	France	56	4.0	24	2.0	5	0.151
8	Germany	60	4.4	11	0.8	3	0.150
7	Slovenia	28	1.3	32	2.5	10	0.171
6	Hungary	1	0.0	43	3.5	20	0.211
5	Slovak Republic	1	0.0	47	3.9	11	0.188
4	Czech Republic	1	0.0	30	2.4	9	0.168
3	Austria	1	0.0	20	1.6	15	0.195
2	Switzerland	1	0.0	8	0.7	6	0.156
1	Luxembourg	1	0.0	5	0.3	1	0.129

GAIN--Global Adaption Index. e--Estimate.

All of the sovereigns in the Top-20 most vulnerable nations are emerging markets, and almost all of them are in Africa or Asia. In contrast, in the Bottom-20 least vulnerable advanced economies dominate, with Luxembourg, Switzerland, and Austria the least vulnerable in the whole sample (see map for a simplified geographical representation).



As we can see from chart 1, lower-rated sovereigns tend on average to be more vulnerable than higher-rated sovereigns. The average vulnerability rank of 'AAA'-rated sovereigns is 18; that of the 'B'-rated sovereigns 84. This indicates that over a long time horizon, climate change could contribute to diverging ratings. Sovereign ratings could diverge further if the lowest-rated sovereigns do in fact experience the greatest impact from changing weather patterns and rising sea levels. The more vulnerable sovereigns also tend to be poorer (see chart 2), which makes it especially challenging for them to invest in mitigation measures that would help them to adapt to changing climate patterns.

Chart 1

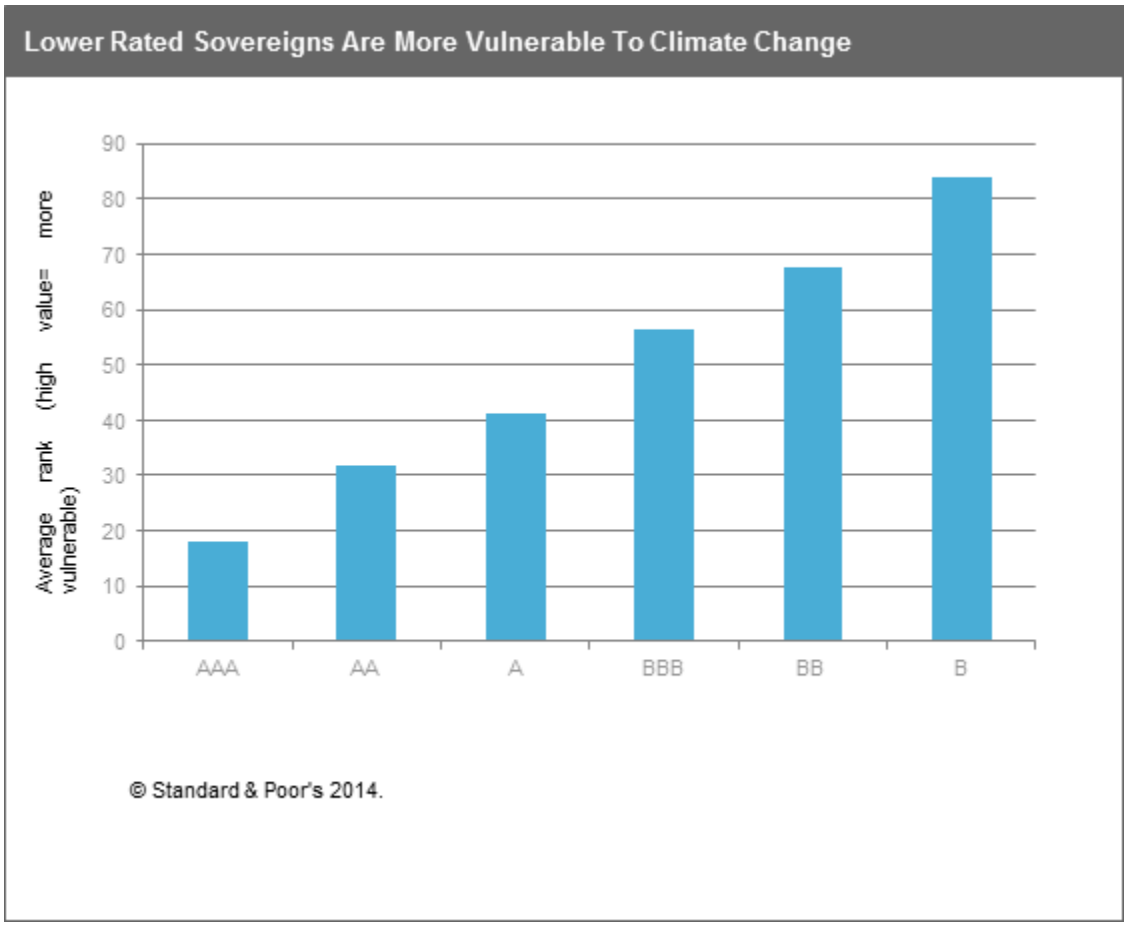
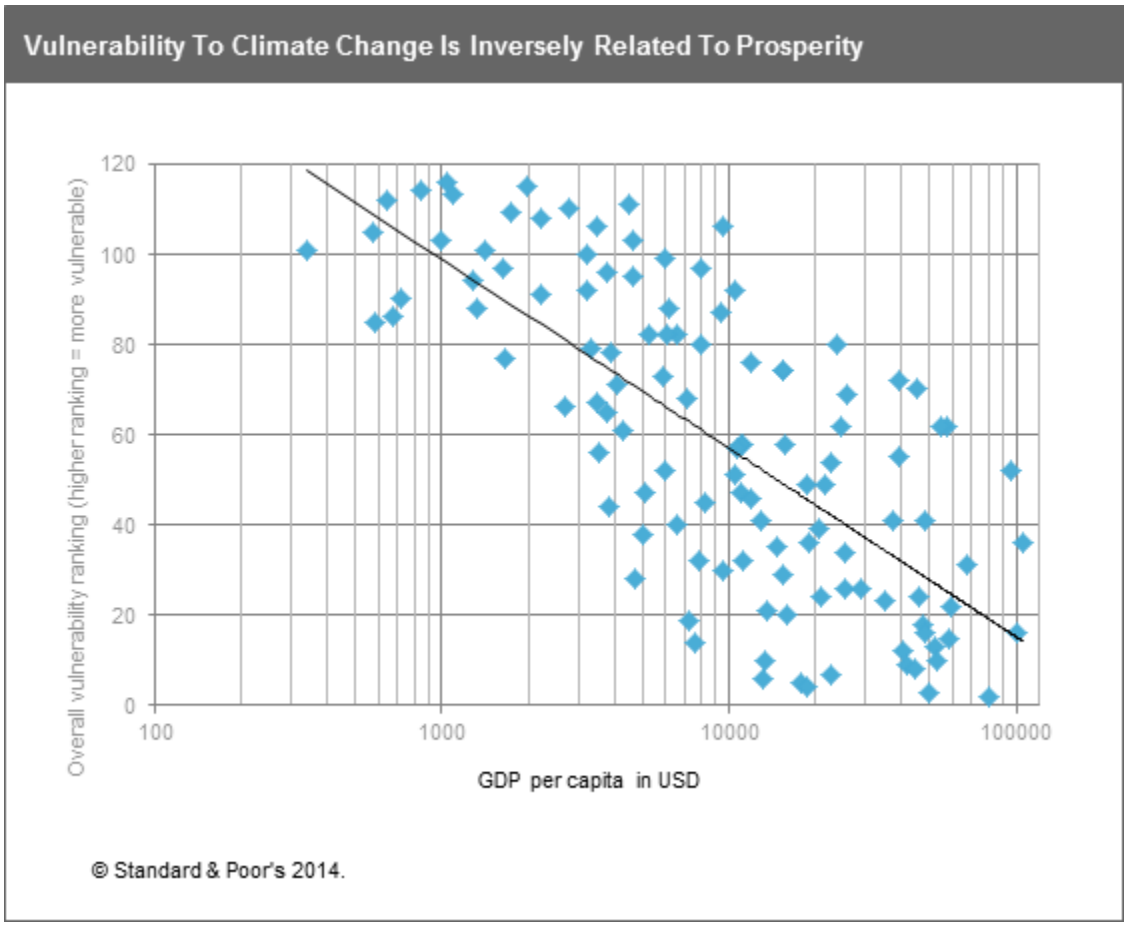

Lower Rated Sovereigns Are More Vulnerable To Climate Change
Average rank (high value= more vulnerable)
90
80
70
60
50
40
30
20
10
0
AAA
AA
A
BBB
BB
B
© Standard & Poor's 2014.

Chart 2



Upcoming negotiations under the United Nations framework could alter the picture for global action on climate change. The Paris conference scheduled for the end of 2015 is aimed at achieving a legally binding and universal agreement, while a leader's summit in New York in September 2014 is likely to mark the starting point for a year of intense political manoeuvring. It's too early to say whether these forums will produce a clearer consensus on global policy or significant changes to emissions targets. Either way, we expect the significance of this mega-trend in assessing sovereign risk to only increase over coming decades, as evidence of the economic implications of climate change and extreme weather events becomes ever more visible.

Notes

(1) MunichRe (2013): "Severe Weather in Eastern Asia: Perils, Risks, Insurance" (Figure 5).

(2) Cheng X. and Zhang D. (2011): "Recent Trend of Flood Disasters and Countermeasures in China". In Chavosian A./Takeuchi K.: "Large Scale Floods Report", ICHARM, Tsukuba, Japan. (p. 192-196).

(3) Nicolas Stern (2013): "The Structure of Economic Modelling of the Potential Impacts of Climate Change: Grafting Gross Underestimation of Risk onto Already Narrow Science Models", Journal of Economic Literature 51(3), p.

839-859.

Related Criteria And Research

- Sovereign Government Rating Methodology And Assumptions, June 24, 2013
- Cracks Appear In Advanced Economies' Government Infrastructure Spending As Public Finances Weaken, Jan. 14, 2014
- Global Aging 2013: Rising To The Challenge, March 20, 2013