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Global environmental change and country risk in emerging markets

- Despite the long time horizon and corresponding forecast uncertainty, the inclusion of environmental risk factors in country risk assessment for emerging markets will likely gain in importance in the future. This paper aims to provide an orientation on what could become one of the very consequential trends of this century: the economic fall-out of new environmental risks.
- At this stage of scientific knowledge about global environmental processes, and in the absence of sophisticated economic models, environmental factors such as climate change, natural disasters, epidemics, growing pollution or shortage of water can be included in the framework of conventional country risk analysis by looking at the potential impact of new environmental risks on tested and proven risk indicators.
- One can identify four key country-risk variables on which the aforementioned global environment trends could have serious repercussions: the economic performance, the fiscal position, structural social indicators, and political risks.
- In a preliminary relative rating, it appears that countries can be broken down into three groups: high, medium and low risk. The high risk group includes the important emerging markets of India, Turkey, and South Africa. A medium risk level exists for Israel, China, and Indonesia, and to a lesser extent also for the main Latin American markets. Most other countries belong to the low risk group, including the Eastern European transition economies as well as Korea, Vietnam, and Chile.
- One method to correct these results for possible technological advances and innovative solutions to environmental problems is to adjust for research and development spending in relation to GNP. Applied to the present rating, South Africa and Israel currently seem better prepared to cope with the effects. Turkey, Indonesia and some African countries could be even more seriously exposed to environmental risks.

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Global environmental change and country risk in emerging markets

The debate about the pace and depth of human-induced changes of the ecological and social environment has been one of the most thrilling in the past decade. Natural and social sciences alike have tried to come to terms with the new risks stemming from the uncertain outlook for the global ecological and social environment (see table 1): the climate change and the rise of the sea level, industrial pollution of air and water, shortage of water supply, natural disasters and the spread of epidemics such as AIDS and malaria nowadays have a central place in development economics and international political economy.

Financial markets actors have so far shown little interest in these issues, partly because of the limited degree of forecast accuracy and partly because of the long time horizon for these phenomena. Yet this negligence is also due to a certain degree to the lack of precise investigations into how environmental phenomena could reduce the liquidity and solvency of emerging market borrowers.

Integration of environmental risks into country assessment

In addition to making these issues accessible to financial market participants and bringing together often-quoted anecdotal facts (epidemics in Africa, water shortage in the Middle East etc.) into a single framework, this paper aims to describe and assess the specific vulnerabilities of individual emerging market sovereigns. For this purpose, we try to establish a suitable framework to facilitate more precise judgements on how well-known country risk indicators like the fiscal position or economic performance could be put under strain by the aforementioned environmental processes. The aim is not to devise a whole new rating system, but to integrate the new phenomena into tried and tested risk indicators. The advantage is clear: it allows tackling new issues within the established framework for assessing country risks by targeted and timely modification instead of uncertain new modelling or complete disregard. The definition of country risk underlying this paper is broad. Country risk here features as the risk of full or partial losses to financial investment because of illiquidity, insolvency, or economic and political disruption through war, revolution or radical political measures on the part of the borrower.

What about the time horizon?

The time factor is of utmost relevance to investors, and the time horizon for most structural environmental processes is rather long: a 20 to 50-year horizon is well beyond the "normal" view of investors (nonetheless, some are day-to-day risks like the occurrence of natural disasters or conflicts over water issues). However, what matters for investors is not only the distant repayment risk, but also the future market value of their investments. In this sense, if structural environmental processes become more visible, specific assets could undergo significant increases in market risk premia already on a 5 to 10-year horizon as refinancing conditions are perceived to worsen or domestic policy priorities to alter dramatically because of more visible problems.

The recent abolition of drug patent rights in some emerging markets - the difficult ethical debate about the pros and cons put aside - could in this sense be read as a first shift in policy objectives which could one

Table 1: the main environmental risks

- Global warming and rise of the sea level
- Industrial pollution of air and water
- Excessive usage of chemical fertilisers
- Shortage in water supply
- Destruction of the ozone layer
- Natural disasters
- AIDS and other epidemics

day also apply to other fields of public policy, i.e. debt service. All in all, there can be little doubt that global environmental change will have growing relevance for investment in emerging markets. This said, new environmental risks remain difficult to grasp in both their global and country-specific relevance.

What are the main environmental risk factors?

A detailed discussion of all changes to global environmental conditions lies beyond the scope of this paper. Instead we focus on those changes that seem to be most obvious and consequential: global climate change, industrial pollution, shortage in water supply, natural disasters and AIDS. What follows is a brief overview of the current state of scientific analysis:

Global climate change

Global climate change is believed to be a consequence of the emission of so-called greenhouse gases, the main ones being carbon dioxide, nitrous oxide and methane. Although the average global temperature increased "naturally" by 5° C during the last 10,000 years, human activity is thought to be accelerating this process hundred-fold. According to estimates of the United Nations, the global temperature could increase by between 1.5 and 4.5° C during the next 100 years, leading to an average sea-level rise of between 15 and 100 cm for the same period. Moreover, climate change is suspected to be the cause of more frequent and more severe natural disasters.

Natural disasters

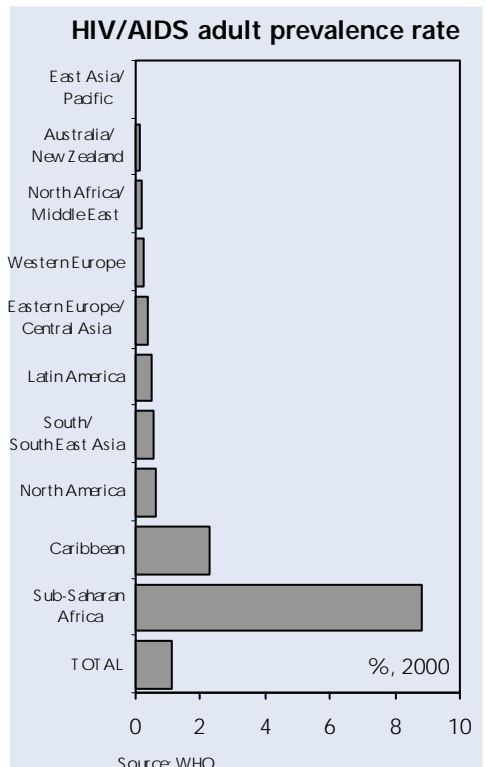
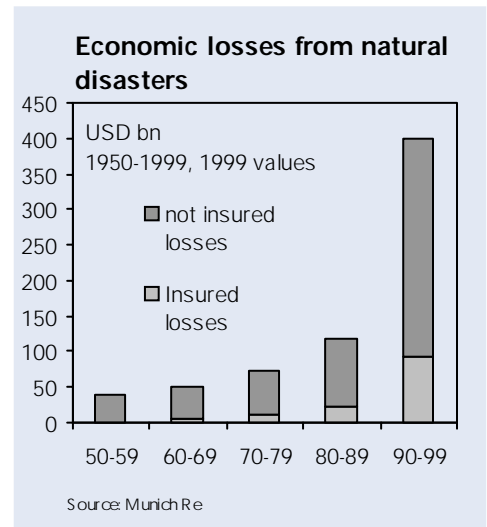
As a likely consequence of various human activities the frequency and severity of natural disasters such as floods, droughts, hurricanes and large-scale fires are expected to increase dramatically in the next decades. As reported by the UN, the number of these events already came to approximately 2,000 during the last decade, five times higher than the average of the last fifty years. Costs in relation to GDP have risen by approximately the same figure (Munich Re: 1998). In the 1990s around one hundred thousand people were killed each year and more than 200 million suffered from natural disasters (UN 1997).

AIDS

The human immunodeficiency virus (HIV), which causes the acquired immune deficiency syndrome (AIDS), appeared around three decades ago. By the year 2000, 21 m people had died since the beginning of the epidemic, 36 m people live with HIV/AIDS and more than 5 m were newly infected in 2000 (UNAIDS, 2000). About 90 percent of infection appears in developing countries, especially in sub-Saharan Africa.

Toxic pollution

Exposure to toxic industrial emissions into air and water has serious negative consequences for human health and the medical conditions in emerging markets with huge "dirty" industries. Heavy metals and so-called persistent organic pollutants (POPs) cause the development of chronic respiratory and cardiovascular diseases, cancer, various types of poisoning, kidney and mental damage and significantly add up to 25 percent of all preventable ill health in the world caused by poor environmental standards (WHO, 1998).



Water supply

During the last century water consumption increased six-fold, about twice the rate of population growth. Currently around one-third of the population lives in water-shortage conditions and, if the trend continues, by 2025 every second person on earth will experience water-supply stress (OECD, 2000). Not only the quantity, but also the quality of water is diminishing, under the pressure of exposure to agricultural fertilisers and industrial waste, making water disputes one of the most serious risks to peace in the developing world.

How do these processes affect country risk?

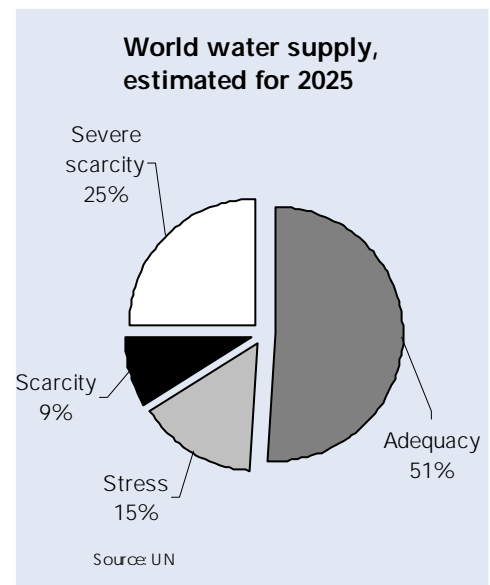
One can identify four key country-risk indicators on which the aforementioned global environmental trends could have serious negative repercussions. Each of these risks is influenced by all the environmental risks shown. But to make it easier to use the risk model that we are in the process of developing, we classify environmental factors under the specific risks with which they have a relatively close and noticeable relationship:

- Economic performance is a key country-risk variable indicating the capacity of an economy to generate higher levels of wealth. Especially the global climate change could lead to negative effects on growth: both the loss of land close to coastlines where most industrial activity is concentrated and the effect of global warming on agricultural harvests carry the potential to significantly reduce growth in affected countries.
- Deterioration of the fiscal position and thus potentially higher deficits and indebtedness as well as fewer resources for debt repayment can quickly reduce a country's creditworthiness. Pressure on the budget is likely to be mainly the result of more frequent and more severe natural disasters because of the infrastructure and social-relief costs of such events.
- A worsening of social and medical conditions has always been a major structural risk factor for economic activity by reducing the human capital of an economy, decreasing productivity and endangering internal political stability. Both AIDS and growing toxic pollution have already led to serious deterioration in this field.
- Serious political risks could stem from the growing shortage of water in many parts of the world.

Building an environmental risk rating

There are various studies which attempt to capture environmental trends in aggregated indicators, but very often their focus is either purely on environmental issues, or on the impact of economic activities on the environment.¹ We therefore used specific indicators designed to link new environmental risks to the aforementioned country risk factors - economic performance, fiscal position, social conditions and political risks - which have proven useful to assess the creditworthiness of a country (see table 2). The cross-correlation of individual indicators is always a problem in building country rating models, but especially so if there are hardly any reliable models and almost no historical data

¹ De Bruyn and Opschoor (1997) discussed the theoretical and empirical sides of measuring environmental quality. Van den Bergh and van Veen-Groot (1999) constructed an index for 12 OECD countries, capturing economic pressure on the quality of the environment. See also Hope, Parker and Peake (1992) and den Butter and van de Eyden (1998).



allowing for a more sophisticated analysis. Under these conditions, a simple scoring model with normalised relative orders of individual countries proves to be the most straightforward assessment. In turn, this warrants caution in reading the results. They do not give absolute crisis risks, but only a relative ranking of the 22 emerging markets under scrutiny here. The most endangered country is attributed the value of 1. A country with a score of 0.5 is in this model only half as likely as the first country to witness a deterioration of its fiscal position or a serious growth slowdown, but the absolute probability cannot be derived.

In our first step, we rated the countries within the aforementioned four different risk categories. This enabled us to determine specific vulnerabilities of individual emerging markets. In a second step we calculated an unweighted average of the four risk categories and thus arrived at an overall rating. The final step was to adjust the overall rating for prospects for technological advances that could mitigate these risks or increase the likelihood of successful risk management by taking into account research and development expenditure (public and private).

Table 2: environmental risks and country risk

Key country-risk indicator	Environmental factor	Indicator	Units	Source
Economic performance	Global warming	Land losses	severity, scale 1-3	Hadley Centre for Climate Prediction and Research
		Effect on agriculture	change in crop yields by 2050, %-points adj. for share of agriculture in GDP	Hadley Centre for Climate Prediction and Research
Deterioration of fiscal position	Natural disasters	Damage from natural disasters, 1980-1999	% of GNP in 1999	CRED
Social conditions	Industrial pollution	Air pollution	carbon dioxide per capita	World Bank
		Water pollution	organic pollutants per day per worker	World Bank
	AIDS	Affected population	adult population, infected by HIV/AIDS, %, 1999	World Health Organization
Political risk	Water supply	Water supply	cubic meters per capita	World Bank
		Historical conflicts over water, 1950-present	yes/no	The World's Water
Adjustment for technological progress		Expenditures for R&D	% of GNI, 1987-97	World Bank

Rating by individual risk categories

1. Risk of worse economic performance due to the effects of global climate change

Our rating in this risk category is built on two indicators, one capturing the potential land losses due to the rise of the sea level and one for the effect of global warming on agricultural output. Beyond any doubt, economic performance in various countries could suffer from the rise

of the average sea level caused by global warming. Taking into account that about 60 percent of the world population lives within 100 km of the coastline, the major share of economic activity is concentrated in areas close to the coast too. Land losses due to a higher sea level are estimated to be most severe in Southern Asia and South East Asia: China, India, Malaysia and Indonesia. For each region, this could possibly affect an area that is home to more than 50 m inhabitants.

Concerning the effect of global warming on agriculture, the UN estimates that India could lose around 20 percent of crop yields by 2020, 30 percent by 2050 and up to 40 percent by 2080, given the current trends in climate change. Taking into account that agriculture constitutes almost one-third of India's GDP, the impact on India's growth would be significant.

Combining both indicators it appears that economic development in India is likely to suffer most from the global climate change (see table 3). The rise of the sea level will pose problems for the densely populated coastline regions, while temperature increases could lead to serious losses in agricultural output. Of the larger economies also Mexico, Turkey and - in view of its unique geographical conditions - Indonesia, could face relative growth constraints due to the effects of global warming, albeit to much lesser extent than India.

2. Risk of a deterioration of the fiscal position due to more frequent and severe natural disasters

For obvious reasons we lack reliable predictions about natural disasters, so in this risk category we refer to historical data and assume that while the risks increase globally, the distribution of risk will by and large remain the same. Natural disasters put additional pressure on public finances by forcing the government to increase spending for the reconstruction of infrastructure or for alleviating the social consequences of such shocks. The hurricanes that destroyed large parts of Central America in the past five years are a strong reminder of the devastating economic effects for whole regions and their population.

Looking at the past two decades, the frequency and severity (in relation to GDP) of natural disasters put Iran and Indonesia on top of the countries where the budgetary position could be put under strain also in the future (see table 4). To a lesser extent natural disasters are likely to become or remain costly in China and Vietnam, where floods are frequent and increasing usage of water energy induces changes in the natural balance. Turkey's vulnerability to earthquakes is a special case, but nonetheless a constant burden for public finances.

3. Risk of worsening social conditions due to epidemics and pollution

Looking at this structural category of country risk three suitable indicators could be included: the rate of AIDS prevalence, and proxies for the degree of water and air pollution as calculated by the World Bank. In addition to epidemics that strike the continent as a whole (such as malaria), AIDS has a dramatic effect on the health and life expectancy of people in the southern parts of Africa. The socio-economic impact of AIDS is significant through the destruction of the economies' human capital and social systems. Taking into account that most infected persons are young adults at the peak of their economic potential and that family support and education of children would have to be provided by this generation due to insufficient social security, AIDS dramatically widens poverty and economic inequality. South Africa has a dramatic AIDS prevalence rate: around 20 percent of all the population is infected by HIV. According to UN estimates, GDP in South Africa in 2010 will be 17% lower than it would be in the absence of AIDS (UNAIDS, 2000). Nigeria follows next, with more than 5

Table 3: worsening of economic performance due to climate change

(1.00 = most affected country)

India	1.00
Nigeria	0.72
Iran	0.68
Mexico	0.66
Egypt	0.65
Indonesia	0.64
Turkey	0.64
China	0.63
Algeria	0.60
Malaysia	0.58
Israel	0.54
Vietnam	0.52
South Africa	0.46
Saudi Arabia	0.41
Korea	0.37
Poland	0.35
Brazil	0.33
Chile	0.32
Argentina	0.30
Kazakhstan	0.25
Russia	0.22
Czech Rep.	0.19

Table 4: fiscal deterioration due to natural disasters

(1.00 = most affected country)

Iran	1.00
Indonesia	0.88
China	0.69
Algeria	0.67
Turkey	0.64
Vietnam	0.51
India	0.32
Chile	0.22
Russia	0.22
Argentina	0.19
Poland	0.18
Mexico	0.16
South Africa	0.12
Korea	0.07
Brazil	0.05
Israel	0.04
Nigeria	0.03
Egypt	0.02
Saudi Arabia	0.02
Czech Rep.	0.02
Kazakhstan	0.01
Malaysia	0.01

percent of its population being infected. In view of these dramatic figures, South Africa and Nigeria come first in the rating despite moderate water and air pollution levels (see table 5).

The relatively high scores of countries such as Argentina, India and Brazil despite a comparatively low AIDS prevalence rate can be explained by high toxic pollution of water and air. The use of chemical fertilisers, polluted mega-cities, dirty industries, and low hygienic standards considerably reduce socio-medical conditions and the long-term productivity of the workforce. Also some Central and Eastern European transition economies like the Czech Republic and Poland score relatively high because of the remnants of communist-era heavy industries which are being dismantled only slowly.

4. Increased political risks due to water shortages

Human history is full of conflicts over water. The number of such conflicts looks set to rise further with growing scarcity of this vital resource, the reasons being uninterrupted population growth, pollution and industrial use of the available fresh water. In order to capture increased political risks from potential military conflicts over water supply, two indicators were used: the availability of water per capita, and the historical record of conflicts over water issues. Since 1947 there have been around 25 such disputes (13 of which were violent) which involved over 30 countries (Gleick, 2000).

The Near and Middle East as well as parts of Africa (including South Africa) stand out as regions with the most pressing political risks attributable to severe water scarcity (see table 6). Israel, Egypt, Turkey and Iran all suffer from scarcity or severe scarcity of less than 1,000 cubic metres of water per capita. One of the most crucial issues in the region is the Nile in North Africa, whose stable water volumes Egypt intends to defend for the sake of its rapidly growing population, yet without controlling the river's sources. South Africa, too, has experienced both scarcity and political conflicts over water supply in the past 20 years, its current supply is under "stress" according to World Bank categories. India, Brazil, and Malaysia have relatively safe internal water supplies, but all three countries were in the past involved in water disputes with neighbouring countries which increase their score.

Aggregated rating and adjustment for technological advances

Arithmetically averaging the scores of the four risk categories three different country groups appear (see table 7): group 1 includes those countries most at risk from the global environmental processes: Iran, India, South Africa and Turkey constantly score high in the four affected country risk categories. India's high exposure to the effects of global warming in addition to non-negligible levels of increasing toxic pollution, South Africa's AIDS and water problems, and Turkey's vulnerability to natural disasters and possible conflicts over water distribution in the Near East place those three key emerging markets in the highest risk group. The second group denotes the countries with medium risks. Those countries achieve very high scores only in one or two risk categories. Israel (water), China (land losses, natural disasters), and Indonesia (disasters, land losses) reach almost 60% of Iran's risk level. In the Latin American countries of Brazil, Mexico and Argentina, industrial pollution plays the main role. The last group can be regarded

Table 5: worsening of social conditions through pollution and AIDS

(1.00 = most affected country)

South Africa	1.00
Nigeria	1.00
Argentina	0.66
Algeria	0.58
India	0.57
Brazil	0.53
Saudi Arabia	0.49
Malaysia	0.48
Israel	0.46
Chile	0.46
Czech Rep.	0.46
Mexico	0.43
Poland	0.43
Russia	0.42
Kazakhstan	0.38
Korea	0.37
Vietnam	0.35
Iran	0.32
Turkey	0.28
Egypt	0.28
China	0.27
Indonesia	0.25

Table 6: political risks due to water shortage*

(1.00 = most affected country)

Israel	1.00
South Africa	0.99
Egypt	0.99
Turkey	0.98
Iran	0.98
India	0.93
Brazil	0.88
Malaysia	0.88
Saudi Arabia	0.50
Korea	0.50
Algeria	0.50
Czech Rep.	0.49
Poland	0.49
Mexico	0.48
Argentina	0.48
China	0.45
Kazakhstan	0.41
Nigeria	0.36
Chile	0.28
Russia	0.28
Indonesia	0.13
Vietnam	0.00

*domestic and in neighbouring countries

as low-risk countries (in relative terms!). In Poland, Korea, and Russia, environmental problems can certainly occur in specific fields, but a significant deterioration of country risk indicators looks rather unlikely.

Adjusting these results for research and development (R&D) spending (in relation to GNP) alters the order of countries significantly (see table 8). While Iran's rating position remains stable and India's improves, South Africa leaves the first tier of most-endangered countries due to its relatively high R&D spending and the level of technological sophistication already reached. Following Iran, Turkey is now the most endangered emerging market. Indonesia also devotes relatively little money to R&D and accordingly climbs in our environmental risk rating. On the other side, countries like Korea and Israel see their environmental country risks considerably reduced.

Conclusion

More investigation into environmental risks will be needed to gain more detailed insights into the economic consequences of these global trends. A relative ranking of countries can in this sense be only a first step towards building rational expectations. What can be said is that for the high risk countries environmental risks might well become a serious issue, in some cases on a not so distant horizon. Especially water issues and the growing impact of natural disasters already warrant awareness for environmental risks.

It is inherently difficult to assess the extent to which these new risks will worsen investment conditions. It corresponds to the very nature of these new risks that their impact can only gradually be captured. The present comparative study includes a relatively large number of emerging markets and could serve as a first orientation in this respect. More detailed country-by-country studies will have to follow, and by the same token attention will have to be given to new scientific insights into the magnitude of environmental risks.

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Table 7: environmental risks (without R&D)

(1.00 = most affected country)

Iran	1.00
India	0.95
South Africa	0.87
Turkey	0.86
Algeria	0.79
Nigeria	0.71
Israel	0.69
China	0.69
Malaysia	0.65
Egypt	0.65
Indonesia	0.64
Brazil	0.60
Mexico	0.58
Argentina	0.54
Poland	0.49
Saudi Arabia	0.48
Vietnam	0.46
Korea	0.44
Chile	0.43
Czech Rep.	0.39
Russia	0.38
Kazakhstan	0.35

Table 8: environmental risks (adj. for R&D)

(1.00 = most affected country)

Iran	1.00
Turkey	0.93
Nigeria	0.92
India	0.92
Algeria	0.89
Indonesia	0.89
South Africa	0.88
Egypt	0.87
Malaysia	0.86
Mexico	0.81
China	0.80
Argentina	0.78
Brazil	0.72
Kazakhstan	0.69
Saudi Arabia	0.69
Vietnam	0.68
Poland	0.67
Chile	0.66
Russia	0.59
Czech Rep.	0.53
Israel	0.46
Korea	0.23

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