WATER

ESTIMATES GLOBAL CARBON IMPACT

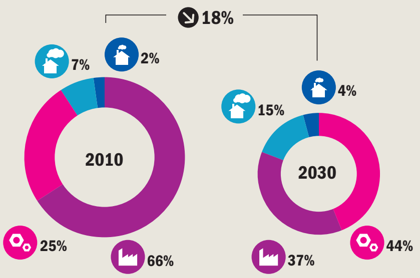
2010 EFFECT TODAY

USD **LOSS** PER YEAR **5 BILLION**

2030 EFFECT TOMORROW

USD **LOSS** PER YEAR **10 BILLION**

ECONOMIC IMPACT



CONFIDENCE
INDICATIVE

SEVERITY

AFFECTED

MDG EFFECT

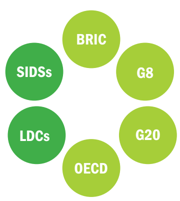
- Bodies of fresh water become acidic when continuously subjected to highly acidic rainfall as a result of air pollution from local or regional heavy industries
- Local vulnerabilities are higher where soils are more acidic and fail to reduce the acidity level of polluted rains
- Acidic water is toxic for fish, if used for irrigation it is toxic for crops, if drunk it is toxic for human health, and if used for industrial purposes, it can corrode and damage technical infrastructure
- If acidic water is not treated, the costs incurred further down the supply chain are likely to be greater and more harmful to populations and the economy

RELATIVE IMPACT

HOTSPOTS

2010	$	2030
1,500	USA	2,250
300	BELARUS	1,250
200	POLAND	650
100	UKRAINE	600
100	RUSSIA	500

GEOPOLITICAL VULNERABILITY



$ Economic Cost (2010 PPP non-discounted)
Developing Country Low Emitters · Developed
Developing Country High Emitters · Other Industrialized

$ = Losses per million USD of GDP

Change in relation to overall global population and/or GDP

$ = Millions of USD (2010 PPP non-discounted)

Acid rain is a by-product of heavy industrial emissions, in particular nitrogen oxide (NOX) and sulphur dioxide (SO2). Acid rain has a variety of effects including the acidification of inland bodies of water, such as lakes and rivers. Problems resulting from acidic water include reductions in agricultural productivity, water biodiversity, human health and recreational options. (Driscoll et al., 2001; Vörösmarty et al., 2010). Water can, of course, be treated to reduce acidity, but at a cost. The level of heavy industrial emissions does not directly correspond to the highest levels of vulnerability because of the complex role that soil chemistry plays in attenuating or exacerbating the impact of acid rain. Soils that have been subjected to heavy emissions for long periods of time have their capacity to buffer acid rain depleted and allow more acidity to accumulate in bodies of water (Jeziorskietal et al., 2008). This explains why industrialized nations from Russia through western Europe to North America are particularly vulnerable to acid rain, while for the time being China, whose concentrations of acid rain are the world's highest, is still relatively resilient to its impact (OECD, 2012). China's buffering capacity has also been enhanced in the north of the country by natural alkaline dust blown in from the deserts (Larssen et al., 2006). Other recently industrialized countries like Thailand have been less fortunate and suffer more severe effects. The impact of air-borne pollution on water resources is widespread and understood to inflict significant damage for a wide-ranging group of economies across Africa, Asia and Europe in particular.

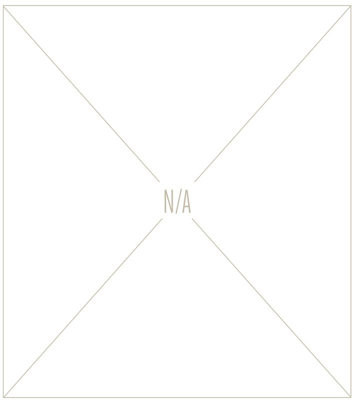
HAZARD MECHANISM

Practically everywhere where dense heavy industry is found today there are significant local sources of highly acidic aerosols, such as sulphur and nitrogen dioxide. A share of these aerosols finds its way to ground level within a certain proximity to the source of emissions (Mehta, 2010). Acidic emission debris is distributed either through acid rain or as dry deposits, where, if the supply is continuous, it accumulates and can render entire bodies of water highly acidic: in some northern and eastern areas of the US, the EPA gauged through a survey in the 1980s that 4.2% of all lakes and 2.7% of streams were acidic (Stoddard et al., 2003). Acidic water has measurable impacts on organisms, and at a certain level becomes lethal to most fish species (Ikuta et al., 2008). Acidic water is also toxic for human consumption in many cases, because it increases the rate at which heavy metals dissolve, among other concerns (Kumar, 2012). Plants, and hence agricultural production, also suffer losses as a result of sustained exposure to high levels of acidity (World Bank, 2005). Therefore, acidic water must be treated, or else risk incurring higher costs than that of treatment.
Vulnerability to acid contamination of water varies considerably worldwide in accordance with the natural ability of land to neutralize acidity.
The chemical composition and absorptive potential of the soil in particular determines the rate at which acidity shocks can be diffused (Stoddard et al., 2003). Industrialized countries are seriously exposed since buffering capacity has been depleted by more than a century of harmful emissions: China, India and South Africa generally have a high soil neutralizing capacity, whereas the eastern US, western Europe and Russia all have high vulnerability to acid contamination (Vörösmarty et al., 2010).

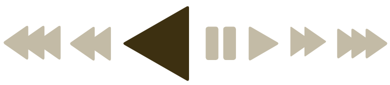
IMPACTS

The global impact of acid rain due to industrial processes on water resources is estimated at a modest five billion dollars in 2010. It is assumed these effects will double by 2030 but remain stable as a share of GDP with losses of ten billion dollars a year.
Around 20 countries are considered acutely vulnerable to the impact of acid rain on water resources, in particular in Africa, Eastern Europe and South-East Asia. The largest share of the impact is estimated to concern Eastern European countries like Belarus and Poland, each of which experienced upwards of 200 million dollars of losses in 2010. The greatest total losses concern the US, with over 1.5 billion dollars of losses per year in 2010. Given the lower levels of emissions among lower-income and least developed countries, many of these are not affected to the same degree as industrialized and major emerging economies, so the effect is not considered a major impediment to poverty reduction efforts.

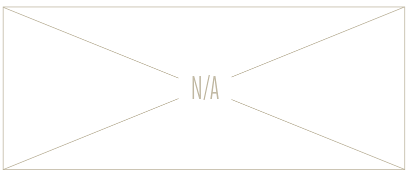
BIGGER PICTURE



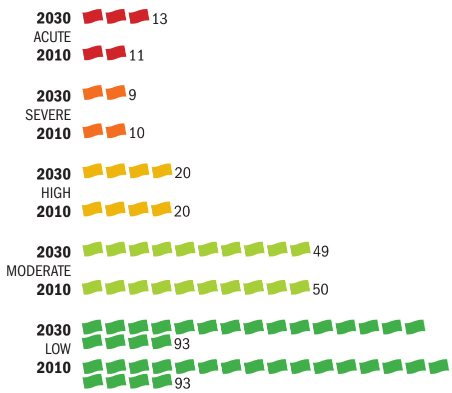
SURGE



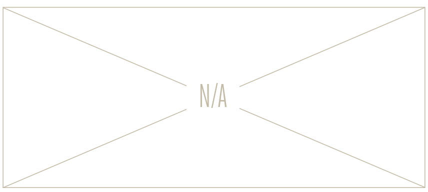
OCCURRENCE



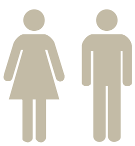
VULNERABILITY SHIFT



PEAK IMPACT



GENDER BIAS



INDICATOR INFORMATION

MODEL: OECD, 2012

BASE DATA: Vorosmarty et al., 2010

= 5 countries (rounded)

Acute Severe High Moderate Low

THE INDICATOR

The indicator measures the impact of acid rain on water. It assesses the extent to which emissions linked to acid rain would be likely to affect ground-level acidity of water bodies, and then calculates the cost of treating the acidified water for the anticipated demand of communities affected (OECD, 2012; Vörösmarty et al., 2010). The indicator assumes a minimal cost basis since untreated water in populated and/or agriculturally productive areas mapped for the purpose would be likely to have greater negative effects than the cost of water treatment (Hoekstra et al., 2010; Portmann et al., 2010). A weakness of the indicator is not factoring in possible changes in soil acid buffering capacity of such rapidly emerging economies like China, which may result in underestimation of 2030 impacts.

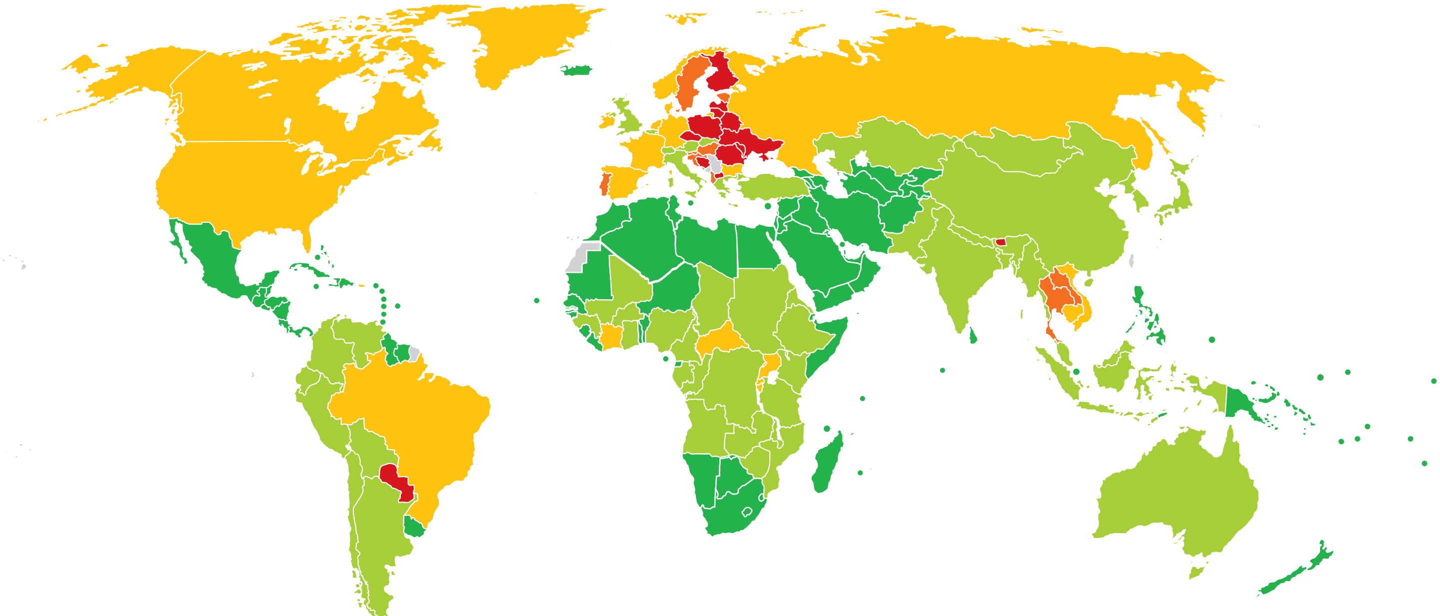
ESTIMATES COUNTRY-LEVEL IMPACT

COUNTRY	$ 2010	$ 2030	◎ 2010	◎ 2030
ACUTE				
Belarus	300	1,250	7,500	10,000
Bhutan	1	5	45	60
Bosnia and Herzegovina	5	25	300	400
Czech Republic	90	250	2,250	2,000
Finland	50	65	1,750	1,500
Latvia	25	100	1,000	1,500
Lithuania	65	300	2,250	3,000
Macedonia	10	45	350	500
Moldova	10	40	1,250	1,750
Paraguay	5	30	500	700
Poland	200	650	6,500	5,750
Romania	75	350	3,500	5,000
Ukraine	100	600	7,250	10,000
SEVERE				
Albania	1	15	150	250
Croatia	10	60	450	650
Estonia	5	15	200	200
Hungary	35	100	1,250	1,000
Laos	1	15	250	350
Portugal	50	65	1750	1,500
Slovenia	10	25	250	200
Sweden	60	80	1,750	1,500
Thailand	85	450	4,750	6,750
HIGH				
Brazil	90	400	6,750	7,750
Bulgaria	5	20	150	200
Burundi		1	200	250
Cambodia	1	10	250	350
Canada	150	200	4,250	3,500
Central African Republic		1	150	200
Cote d'Ivoire	1	10	600	800
Denmark	30	35	1,000	900
France	150	200	4,750	4,250
Germany	350	450	10,000	8,750
Ireland	15	20	400	350
Luxembourg	5	5	65	55
Netherlands	40	50	950	850
Norway	15	20	450	400
Russia	100	500	4,500	5,250
Rwanda	1	1	200	250
Spain	90	100	2,750	2,500
Uganda	1	10	750	1,000
United States	1,500	2,250	30,000	25,000
Vietnam	20	150	2000	3000
MODERATE				
Angola	1	5	150	200
Argentina				1
Australia	10	10	250	200
Austria	15	15	300	250
Bangladesh	1	10	400	550
Belgium	10	10	250	200
Bolivia	1	5	55	75
Burkina Faso			5	10
Cameroon	1	5	200	300
Chad		1	30	40
Chile				
China	45	300	3,250	3,750
Colombia	1	5	70	100
Congo	1	1	80	100
DR Congo	1	5	1,000	1,500
Ecuador		1	10	15
Eritrea			10	15
Ethiopia		1	30	40
Gabon				1
Ghana	1	5	250	350
Greece	10	15	350	300
Guinea			25	35
India	30	150	3,250	3,750
Indonesia	1	5	250	250
Italy	1	1	80	70
Japan	10	10	300	250
Kazakhstan	1	5	55	75
Kenya			5	5
Malawi		1	80	100
Malaysia	1	15	95	150
Mali			5	5
Mongolia				
Mozambique			15	20
Myanmar	1	5	200	300
Nepal			10	15
Nigeria	1	1	90	100
North Korea		1	20	30
Pakistan	1	15	350	500
Peru	1	10	80	100
Slovakia	5	15	150	100
South Korea	30	150	650	850
Sudan/South Sudan	1	1	100	150
Switzerland	1	1	30	25
Tanzania	1	5	350	450
Turkey	5	5	150	250
United Kingdom	95	100	2,500	2,000
Venezuela	5	35	400	550
Zambia			20	30
Zimbabwe			10	10

$ Additional economic costs (million USD PPP) - yearly average

CARBON VULNERABILITY

Acute · Severe · High · Moderate · Low



Vulnerability measure: comparative losses as a share of GDP in USD (national)

COUNTRY	$ 2010	$ 2030	◎ 2010	◎ 2030
LOW				
Afghanistan				
Algeria				
Antigua and Barbuda				
Armenia				
Azerbaijan				
Bahamas				
Bahrain				
Barbados				
Belize				
Benin				
Botswana				
Brunei				
Cape Verde				
Comoros				
Costa Rica				
Cuba				
Cyprus				
Djibouti				
Dominica				
Dominican Republic				
Egypt				
El Salvador				
Equatorial Guinea				
Fiji				
Gambia				
Georgia				
Grenada				
Guatemala				
Guinea-Bissau				
Guyana				
Haiti				
Honduras				
Iceland				
Iran				
Iraq				
Israel				
Jamaica				
Jordan				
Kiribati				
Kuwait				
Kyrgyzstan				
Lebanon				
Lesotho				
Liberia				
Libya				
Madagascar				
Maldives				
Malta				
Marshall Islands				
Mauritania				
Mauritius				
Mexico				
Micronesia				
Morocco				
Namibia				
New Zealand				
Nicaragua				
Niger				
Oman				
Palau				
Panama				
Papua New Guinea				
Philippines				
Qatar				
Saint Lucia				
Saint Vincent				
Samoa				
Sao Tome and Principe				
Saudi Arabia				
Senegal				
Seychelles				
Sierra Leone				
Singapore				
Solomon Islands				
Somalia				
South Africa				
Sri Lanka				
Suriname				
Swaziland				
Syria				
Tajikistan				
Timor-Leste				
Togo				
Tonga				
Trinidad and Tobago				
Tunisia				
Turkmenistan				
Tuvalu				
United Arab Emirates				
Uruguay				
Uzbekistan				
Vanuatu				
Yemen				

◎ Volume of water to treat (millions m^3) - yearly average