TRANSPORT

ESTIMATES GLOBAL CLIMATE IMPACT

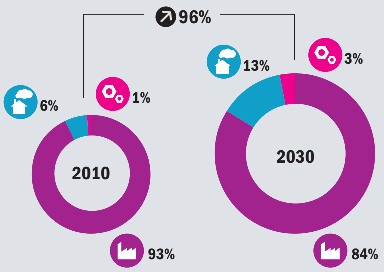
2010 EFFECT TODAY

USD **LOSS** PER YEAR **1 BILLION**

2030 EFFECT TOMORROW

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

ECONOMIC IMPACT



CONFIDENCE
SPECULATIVE

SEVERITY

AFFECTED

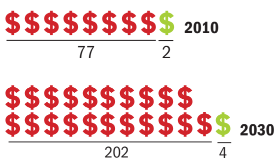
INJUSTICE

PRIORITY

MDG EFFECT

- The impact of climate change on the transport sector is relatively unstudied compared to other areas
- Changes will lead to geographic shifts in volume rather than overall losses
- Apparent net negative effects relate to losses incurred through increasing costs of logistics for inland transport, as some important river levels decline
- These losses are not expected to be offset by gains in transport effectiveness in parts of the world experiencing more flooding of river-ways due to climate change
- Water resource management and conservation are required to limit these effects

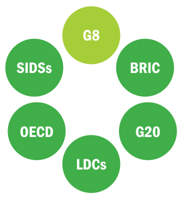
RELATIVE IMPACT



HOTSPOTS

2010		2030
1,000	USA	5,750
75	MEXICO	950
45	GERMANY	200
35	NETHERLANDS	150
10	ROMANIA	100

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)

Only the impact of climate change on river transport is considered here. Many other negative and positive effects of climate change on the transportation sector are conceivable, but difficult to simulate (Koetse and Rietveld, 2009; Eisenack et al., 2012). Climate change, however, can clearly affect the flow of rivers, increasing or decreasing the rate and volume of water over which goods are transported (Stromberg et al., 2010). A number of the world's waterways are already independently stressed due to infrastructure, pollution, or water withdrawals, which can reduce river flows and make them more vulnerable to climate change impacts (Palmer et al., 2008; Sabater and Tockner, 2010). Climate change has been simulated to have potentially serious negative effects on the river levels of some of the world's most important waterways, including the Danube, the Rhine, and the Rio Grande rivers (Nohara et al., 2006). Lower water levels will continue to increase shipping costs for major global transport conduits affected by river level decline, with potentially significant effects for affected communities—for example, the Rhine carries around 70% of all inland waterway transport of the pre-2004 EU-15 (Jonkeren et al., 2007).

CLIMATE MECHANISM

There are also discernable linkages between river flows and climate factors, such as extreme heat, rainfall, and drought (Kaczmarek et al. (eds.), 1996). Increasing temperatures, the earlier onset of spring, longer, hotter summers, long-term glacial decline, and changes in rainfall patterns, among other effects characteristic of climate change, will have an increasing role in determining water levels in the world's rivers. Increased rainfall and heavy flooding will also affect rivers in some places. However, there is little evidence of any beneficial effect from higher river levels, which are more likely to increase flooding and other risks, since most additional water will fall during the rainy season, when flows and supply are in abundance (Arnell, 2004). When river levels decline, an economic loss arises by affecting the maximum cargo payload that can be transported, or the size of ships transporting goods. The inefficiencies thus created increase shipping costs in a predictable way (Jonkeren et al., 2007).

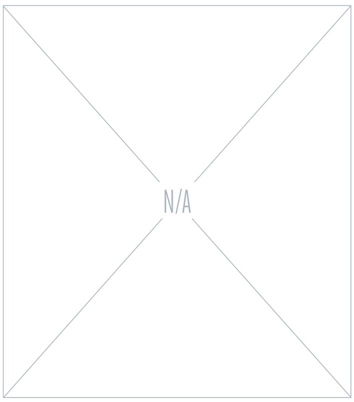
IMPACTS

Only a handful of countries are affected in any significant way by the impact of climate change on river transportation. This is because large-volume, inland, water-borne transportation is a major economic activity in only a few river basins of the world (UNECE, 2012a). Moreover, only a small number of river basins are currently projected to see continued decline, mainly because in many areas rainfall will increase with climate change (Nohara et al., 2006). The costs of climate change on the transport sector as a result of effects for inland water-borne logistics are currently estimated at 1 billion dollars per year, increasing to over 7 billion dollars by 2030 as the effect intensifies and the overall impact grows as a share of GDP. The bulk of all losses are estimated to be incurred in the United Sates, with European countries along the Rhine and Danube, such as Germany and the Netherlands, as well as Bulgaria and Romania, affected to lesser degrees. Mexico also shows high levels of vulnerability, linked to decline of the Rio Grande.
Caution is suggested with regard to the assessment results, which may underestimate the vulnerabilities of several river basins if rainfall patterns were to evolve differently than expected, based on the research relied upon here.

THE BROADER CONTEXT

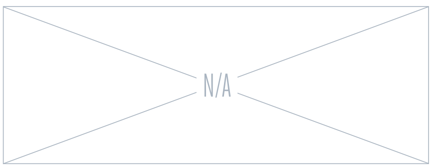
Many factors other than climate change—especially water withdrawals from rivers due to growth in agricultural, industrial, and municipal water demand—can play a central role in the level of rivers (Alcamo et al., 2003). Indeed, so-called "basin" closure—the inability of a waterway to meet local water demands for part of the year—currently affects 1.4 billion people in various river basins around the world (Falkenmark and Molden, 2008). Population growth exacerbates these issues when alternate resources are not adequately managed (Vösösmarty et al., 2000; Palmer et al., 2008).
The transportation and logistics sector is a steady growth industry in a globalizing economy, with no expectation of declining demand, except for passenger transportation in some industrialized country settings (US DoT, 2010; Millard-Ball and Schipper, 2011). Therefore, losses are unlikely to lead to unemployment issues, but rather to generate additional costs for communities that have relied on highly efficient inland water-borne transportation, which can be a major economic benefit.

BIGGER PICTURE

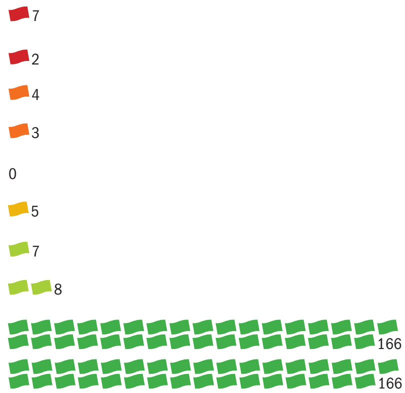


SURGE

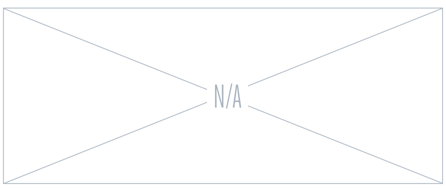
OCCURRENCE



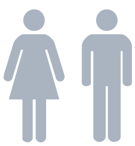
VULNERABILITY SHIFT



PEAK IMPACT



GENDER BIAS



INDICATOR INFORMATION

MODEL: Jonkeren et al., 2011; Nohara et al., 2006

EMISSION SCENARIO: SRES A1B (IPCC, 2000)

BASE DATA: UNECE (2012a)

= 5 countries (rounded)

Acute Severe High Moderate Low

VULNERABILITIES AND WIDER OUTCOMES

In arid regions, water demand for irrigation has an amplified effect on river levels (Kang et al., 2004). Africa may be particularly vulnerable as a result (de Wit and Stankiewicz, 2006). Smaller rivers may also be asymmetrically affected (Pandey et al., 2010). Free-flowing rivers are more resilient than riverways with dams (Palmer et al., 2008). Deforestation or expanded agricultural and industrial activity can further lower resilience to any shocks and river-level decline brought on by climate change (Sahin and Hall, 1996; Conway, 2005). As the effects are currently interpreted, the narrow economic impact is not expected to have many discernable wider outcomes, aside from burdening a handful of countries/communities with additional costs.

RESPONSES

With glacial retreat, growing heat, and rainfall decline out of societal control, responses would likely include some form or combination of water resource management and the enhancement of catchment potential (Palmer et al., 2008; Falkenmar and Molden, 2012). Water resource management could seek to minimize or reduce water withdrawals, especially during high summer or drought periods, as well as increase water re-use and reduce water contaminants from industrial or agricultural sources (Geng et al., 2001; Friedler, 2001; Asano, 2002). Government quotas on irrigation could stimulate broader use of micro-irrigation and other water conservation actions (Pereira et al., 2002; Barret and Wallace, 2011). Water catchment potential can be enhanced through such measures as large-scale forestry expansion and conservation (Sahin and Hall, 1996). Limiting riverine infrastructure also improves resilience (Palmer et al., 2008).

THE INDICATOR

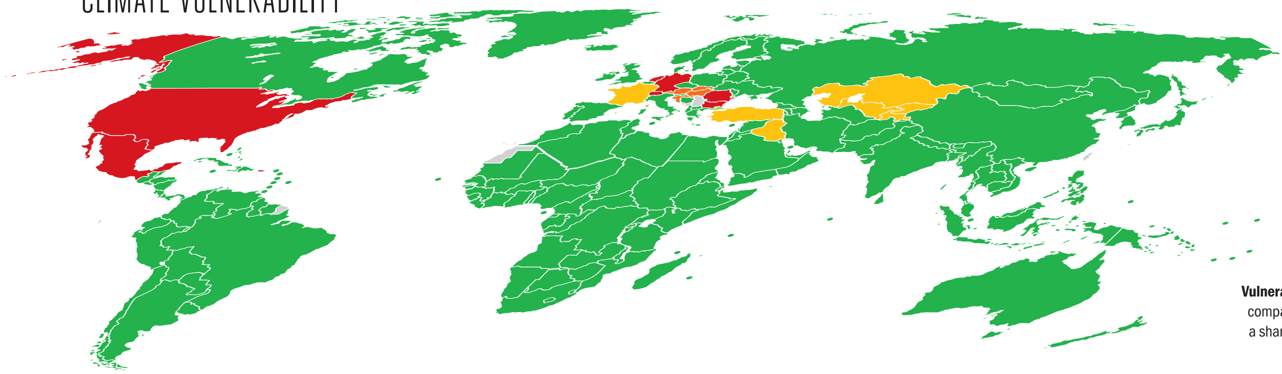
The indicator is considered uncertain and speculative for those countries assessed—provided projections for river flow and levels are accurate (Nohara et al., 2006). The economic effect of river decline relies on a study conducted in the Netherlands, not global research (Jonkeren et al., 2007). But the main limitation of the transport sector indicator relates to its scope, as increasing severity and variability of weather, growing heat stress, and other elements will likely affect the transport industry. Growing tire failure, increased delays and congestion, accidents, and port infrastructure damage have not been studied sufficiently to to build even speculative indicators of global effects (Koetse and Rietveld 2009; Eisenack et al., 2012). The rapid opening of previously inaccessible Arctic passageways will likely benefit, but its dynamics are difficult to ascertain (Macdonald et al., 2005). Additional investigation is needed to better understand the global effects of climate change on the transport sector.

ESTIMATES COUNTRY-LEVEL IMPACT

COUNTRY	$ 2010	$ 2030
ACUTE		
Bulgaria	5	65
Germany	45	200
Mexico	75	950
Netherlands	35	150
Romania	10	100
Switzerland	5	30
United States	1,000	5,750
SEVERE		
Austria	5	15
Croatia	1	10
Hungary	1	25
Slovakia	1	15
MODERATE		
France	5	25
Iraq		
Kazakhstan		
Kyrgyzstan		
Tajikistan		
Turkey		
Uzbekistan		
LOW		
Afghanistan		
Albania		
Algeria		
Angola		
Antigua and Barbuda		
Argentina		
Armenia		
Australia		
Azerbaijan		
Bahamas		
Bahrain		
Bangladesh		
Barbados		
Belarus		
Belgium		
Belize		
Benin		
Bhutan		
Bolivia		
Bosnia and Herzegovina		
Botswana		
Brazil		
Brunei		
Burkina Faso		
Burundi		
Cambodia		
Cameroon		
Canada		
Cape Verde		
Central African Republic		
Chad		
Chile		
China		
Colombia		
Comoros		
Congo		
Costa Rica		
Cote d'Ivoire		
Cuba		
Cyprus		
Czech Republic		
Denmark		
Djibouti		
Dominica		
Dominican Republic		
DR Congo		
Ecuador		
Egypt		
El Salvador		
Equatorial Guinea		
Eritrea		
Estonia		
Ethiopia		
Fiji		
Finland		
Gabon		
Gambia		
Georgia		
Ghana		
Greece		
Grenada		
Guatemala		
Guinea		
Guinea-Bissau		
Guyana		
Haiti		
Honduras		
Iceland		
India		
Indonesia		
Iran		
Ireland		
Israel		
Italy		

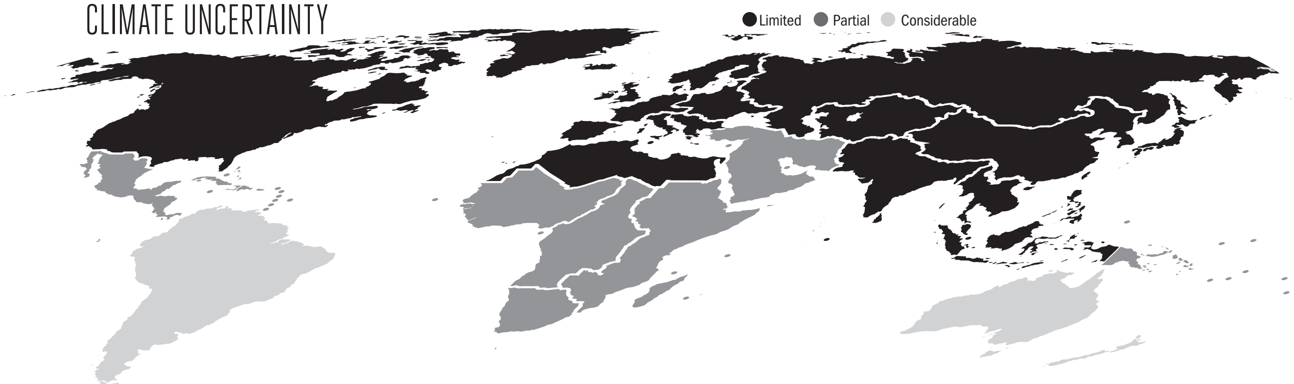
$ Additional economic costs due to climate change (million USD PPP) - yearly average

CLIMATE VULNERABILITY



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

CLIMATE UNCERTAINTY



COUNTRY	2010	2030
Jamaica		
Japan		
Jordan		
Kenya		
Kiribati		
Kuwait		
Laos		
Latvia		
Lebanon		
Lesotho		
Liberia		
Libya		
Lithuania		
Luxembourg		
Macedonia		
Madagascar		
Malawi		
Malaysia		
Maldives		
Mali		
Malta		
Marshall Islands		
Mauritania		
Mauritius		
Micronesia		
Moldova		
Mongolia		
Morocco		
Mozambique		
Myanmar		
Namibia		
Nepal		

COUNTRY	2010	2030
New Zealand		
Nicaragua		
Niger		
Nigeria		
North Korea		
Norway		
Oman		
Pakistan		
Palau		
Panama		
Papua New Guinea		
Paraguay		
Peru		
Philippines		
Poland		
Portugal		
Qatar		
Russia		
Rwanda		
Saint Lucia		
Saint Vincent		
Samoa		
Sao Tome and Principe		
Saudi Arabia		
Senegal		
Seychelles		
Sierra Leone		
Singapore		
Slovenia		
Solomon Islands		
Somalia		
South Africa		

COUNTRY	2010	2030
South Korea		
Spain		
Sri Lanka		
Sudan/South Sudan		
Suriname		
Swaziland		
Sweden		
Syria		
Tanzania		
Thailand		
Timor-Leste		
Togo		
Tonga		
Trinidad and Tobago		
Tunisia		
Turkmenistan		
Tuvalu		
Uganda		
Ukraine		
United Arab Emirates		
United Kingdom		
Uruguay		
Vanuatu		
Venezuela		
Vietnam		
Yemen		
Zambia		
Zimbabwe		