



Double exposure: assessing the impacts of climate change within the context of economic globalization

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Abstract

This paper considers synergisms between the impacts of two global processes, climate change and economic globalization. Both processes entail long-term changes that will have differential impacts throughout the world. Despite widespread recognition that there will be “winners” and “losers” with both climate change and globalization, the two issues are rarely examined together. In this paper, we introduce the concept of double exposure as a framework for examining the simultaneous impacts of climate change and globalization. Double exposure refers to the fact that certain regions, sectors, ecosystems and social groups will be confronted both by the impacts of climate change, and by the consequences of globalization. By considering the joint impacts of the two processes, new sets of winners and losers emerge. © 2000 Elsevier Science Ltd. All rights reserved.

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Starting today, representatives of some 150 countries will meet in Kyoto, Japan, to take what they hope will be the first step in a decades-long effort to cope with the prospect of global climate change. Rarely, if ever, has humanity made an attempt like this one: to exercise deliberate, collective foresight on a risk whose full impact is unclear and will not be felt for decades. (New York Times, 12/1/97)

Globalization is the big economic event of the 1990s. It means that investors anywhere, seated at their computers and using global instant communications, can invest their money in anything — stocks, bonds, property, factories, other countries' money — almost anywhere in the world. . . . Globalization promises benefits galore — jobs and prosperity for Third World countries, global markets for American and other First World companies, cheap imports for U.S. consumers, cost-cutting pressures that will force firms everywhere to be more efficient. (Chicago Tribune, 10/28/97)

1. Global processes

Climate change is emerging as one of the most challenging problems facing the world in the 21st century.

Scientists and policy makers have become embroiled in extensive debates about potential changes brought about by an increase in anthropogenic greenhouse gas emissions, along with strategies for mitigation and adaptation. Assessments of the global and regional impacts of climate change have formed the cornerstone for climate policy debates. Underlying these debates is the recognition that some areas are more vulnerable to climate change than others. Differential impacts superimposed on dissimilar vulnerabilities have resulted in a complex geography of climate change. To add further complexity to the picture, climate change is taking place within a rapidly changing world. In particular, on-going processes of economic globalization are modifying or exacerbating existing vulnerabilities to climate change.

Although globalization and climate change are both considered important areas for contemporary research, few studies have considered the two issues together, particularly from the perspective of impacts. Much more attention has been focused on the implications of globalization, and particularly trade liberalization, for the environment (Bredahl et al., 1996; Esty, 1995; Krissoff et al., 1996; OECD, 1997a, b; Rauscher, 1997). Other key issues that these studies focus on relate to environmental governance, economic competitiveness, foreign investment, sectoral economic policies,

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technological change, business strategies, employment, and environmental policies. While qualitative research has been carried out on many aspects of globalization-environment relationships, OECD (1997a, p. 17) notes that quantitative evidence is currently lacking on virtually all components of the relationship.

A number of studies have addressed the role of global corporations in fostering climatic change. Mason (1997), Robbins (1996) and UNCTC (1992) each examine the environmental practices of transnational corporations (TNCs) and their contribution to greenhouse gas emissions. Robbins (1996) and UNCTC (1992) find that TNCs are major contributors to global emissions of greenhouse gases. Mason (1997) looks at the emissions patterns and environmental impacts of TNC activity, focusing on the aluminum industry. While each of these studies provides important insights into the causes of climatic change, they do not address the joint impacts that globalization and climatic change may have for regions, sectors, ecosystems or social groups.

In addition, several studies have examined the effects of climate change on global agricultural trade, highlighting the impacts on yields, commodity prices, and imports and exports for individual countries (Fischer et al., 1994; Reilly et al., 1994). Neither of these studies, however, considered agricultural interactions with other economic sectors, or structural economic changes that might influence agricultural production, even in the absence of climate change. Reilly et al. (1994) do note, however, that economic restructuring could intensify the effects of climate change through a marginalization of production conditions. To obtain a better understanding of the future of world agriculture and other environmentally sensitive sectors, the joint impacts of globalization and climate change should be examined, with an emphasis on *how* the impacts of each process may exacerbate or offset each other.

In this paper, we establish a framework for examining the impacts of climate change and economic globalization based on the concept of *double exposure*. By double exposure, we refer to the fact that regions, sectors, ecosystems and social groups will be confronted both by the impacts of climate change and by the consequences of globalization. Our point of departure lies in the widely recognized perception that there are “winners” and “losers” associated with both of these global processes. Climate change and economic globalization, occurring simultaneously, will result in new or modified sets of winners and losers. Double exposure has important policy implications, especially for those that are likely to experience the negative consequences of both globalization and climate change.

In Section 2, we examine the notion of winners and losers, including some of the problems associated with

identifying them. In Sections 3 and 4, we consider winners and losers in the context of climate change, and from the perspective of economic globalization. Section 3 introduces the concept of double exposure, and presents some examples. In conclusion, we suggest some issues and questions for future research on globalization and climate change.

In highlighting the synergisms between the impacts of globalization and climate change, this paper does not attempt to survey the causal linkages between globalization and climate change. In addition to the direct contributions of transnational corporations to greenhouse emissions, as mentioned above, globalization may also exacerbate climate change by fostering more rapid development and consequently higher levels of fuel consumption by consumers throughout the world. Conversely, policies intended to control greenhouse emissions may indirectly promote globalization, as industries shift location to avoid enforcement of new emissions standards in certain countries. Rather than focusing on these various causal mechanisms, we emphasize the need to consider the impacts of the two processes simultaneously.

2. Winners and losers

The idea of winners and losers has been referred to frequently in discussions of both climate change impacts and the consequences of globalization. Winners are considered those countries, regions or social groups that are likely to benefit from the ongoing processes of climate change or globalization, while losers are those that are disadvantaged by the processes and likely to experience negative consequences. The notion of winners and losers is contentious in both arenas, as it undermines any consensus on climate change mitigation or economic liberalization.

In discussions of climate change, there is a strong reluctance among scientists and policymakers to recognize, address or discuss the existence and identity of winners and losers, particularly winners (Glantz, 1995). Such discussions are considered by many to be divisive and counter-effective to efforts to gain a global consensus on climate change (Glantz, 1995; Schneider, 1989). Nevertheless, climate impact assessments inevitably point to winners and losers, and the perception alone of winning or losing can significantly influence climate negotiations (UNEP, 1993).

Debates over the impacts of economic globalization are also often focused on the subject of winners and losers (e.g., Conroy and Glasmeier, 1993; Greider, 1997; Tardanico and Rosenberg, 2000). Proponents of economic globalization argue that as the result of increased economic efficiency, everyone eventually benefits from

falling trade barriers and liberalized investment policies. Critics, however, are quick to point out that many regions, sectors, or social groups may be losers in the process of globalization.

Within the context of both globalization and climate change, the identification of winners and losers is not straightforward. It can be considered subjective, relative, and to a large extent based on perception. Glantz (1995) identifies some important questions that should be considered when discussing winners and losers:

- What is meant by a win or a loss?
- What factors must be taken into account in labeling a region, an activity, an economic sector, or a country a winner or a loser?
- Can wins and losses be objectively and reliably identified and measured?
- Can wins and losses be aggregated?
- How do perceptions of winning or losing compare with reality?

In discussing winners and losers in climate change and economic globalization, it is important to first identify what is meant by a win or a loss (Glantz, 1995). In terms of climate change, a win might refer to any net benefit from changes in temperature, rainfall, or climate variability. Such benefits may be measured by increased productivity (e.g. agriculture), increased resource availability (e.g. water), decreased hazards (e.g. frequency of floods), or decreased climate-related expenditures (e.g. heating expenses, snow removal costs). A loss could refer to any adverse effects that result from climate change, such as decreased agricultural productivity, increased water scarcity, or increased climate-related mortality.

In terms of economic globalization, a win is often associated with an improvement in economic performance, as measured by gross domestic product (GDP), foreign direct investment (FDI), employment, trade balance, and so forth. A win can also refer to improvements in social well-being, as represented by various indicators of health, education and access to services. A loss may be defined by economic hardships influenced by globalization processes, such as higher levels of unemployment, increased income inequality, and reductions in social services.

Many integrated assessments of climate change seek to determine whether the net impact of climate change is positive or negative for a given sector, such as energy, agriculture or forestry (Alcamo et al., 1998). The philosophy behind such studies is that regional dislocations and negative impacts caused by climate change may be offset by gains or surpluses elsewhere. Aggregate measures of economic growth also emphasize the net outcome, rather than the local or regional impacts. But as Glantz (1995, p. 51) points out, “wins and losses cannot be meaningfully aggregated. A win is a win,

and a loss is a loss”. Attempts to identify “net” winners and losers gloss over the real impacts, and trivialize the significance for specific regions, sectors, or social groups.

The scale of analysis thus makes a difference in the identification of winners and losers. For example, while globalization, as manifest through the North American Free Trade Agreement (NAFTA) between the United States, Canada and Mexico, may indeed lead to aggregate increases in total employment in all three nations, this increase will not be uniform across different regions of each country (Conroy and Glasmeier, 1993). Rather it will be unevenly distributed, with some regions and groups experiencing large gains, and others experiencing net losses. Shifting scales from groups of individuals or regions to the nation requires aggregation and generalization, such that some losers will not be identified when the country is considered a winner. Likewise, some winners will not be identified when a country is considered a loser. Capturing an overview of winners and losers consequently requires analyses at multiple scales.

It is also important to recognize that winners and losers may shift over time, particularly in the case of economic globalization. For example, a current winner may eventually become as loser. As witnessed by the recent financial crisis in Asia, many countries that have enjoyed rapid growth and increasing living standards as the result of globalization, have, at the same time, becoming increasingly vulnerable to international financial disruptions.

Climate alone is unlikely to determine winners and losers, as vulnerability differences and adaptation measures can significantly shift the outcome of any climate change. Likewise, it is often difficult to isolate the consequences of economic globalization from other social and economic changes. Because the concept of winners and losers is imprecise, it is important to consider it within the social, economic, and environmental context appropriate to different regions, sectors, or social groups.

3. Climate change

There is a growing consensus that anthropogenic greenhouse gas emissions have contributed to a change in the climate, and that such trends will continue into the future unless dramatic mitigation measures are adopted (Houghton et al., 1996). As discussed above, there is a broad recognition that there will be both winners and losers associated with climate change. Although there is a large amount of uncertainty associated with future climate scenarios, it is quite clear that the distribution of winners and losers will be varied, reflecting the diversity of climate change impacts.

Climate change can be considered a spatially differentiated process. Although many areas could experience temperature increases on the order of 1.5–4.5°C, some

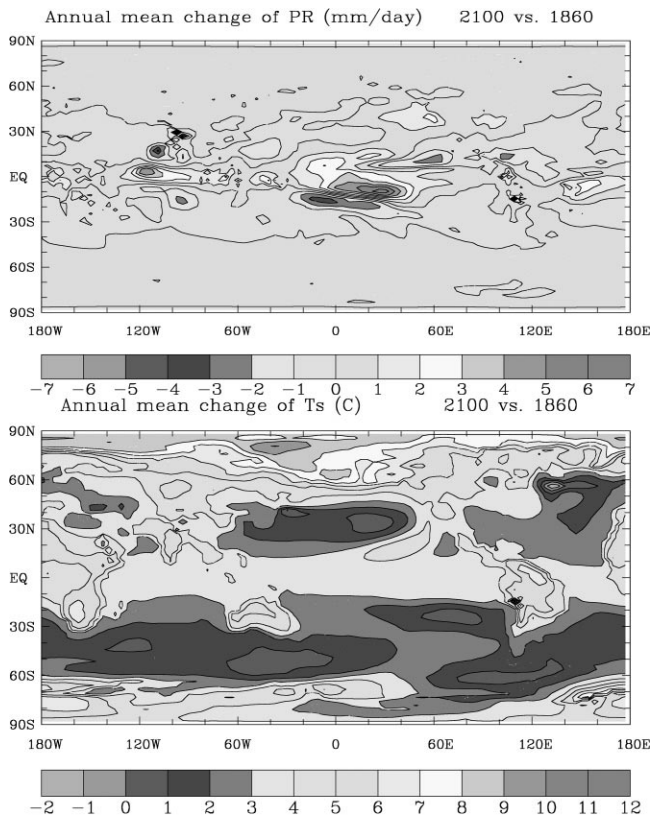


Fig. 1. Climate change results from the Hadley Center Model for precipitation and surface temperature.

areas may actually cool under “global warming” conditions (Houghton et al., 1996). Patterns and amounts of precipitation are also likely to change, and it is projected that rainfall will increase in some areas and decrease in others (Houghton et al., 1996). Although there are difficulties associated with modeling regional and local precipitation, there is little doubt that the impacts will vary across space and time. Fig. 1 shows projected temperature and precipitation changes based on the Hadley Center model. According to this model, the greatest warming will occur at high-latitudes during winter, whereas precipitation changes will be strongest in tropical regions. Some ocean regions will experience minimal temperature changes. However, the model projects changes in ocean circulation that can alter temperature patterns over the North Atlantic, which could, for example, contribute to changes in storminess in Europe (The Met. Office, 1998).

The physical and social impacts of climate change are not considered to be homogenous for two reasons. First, global circulation models project spatial differences in the magnitude and direction of climate change. Second, even within a region experiencing the same characteristics of climate change, the impacts are likely to vary because some ecosystems, sectors, or social groups are more vulnerable to climate change than others.

Vulnerability is varied across space, as well as across social groups. Each “exposure unit” has a unique sensitivity or resilience to climate change that is dependent on an array of factors (Parry and Carter, 1998). The most vulnerable are considered those who are most exposed to perturbations, who possess a limited coping capacity, and who are least resilient to recovery (Bohle et al., 1994). Other definitions of vulnerability focus on concepts of marginality, susceptibility, adaptability, fragility, and risk (Liverman, 1994). In further exploring the concept of vulnerability, Liverman (1994) distinguishes between biophysical vulnerability and social vulnerability. The former refers to the physical conditions of the landscape and how they impact humans or biological diversity. The latter, referred to as a political economy approach to vulnerability, defines vulnerability according to the political, social and economic conditions of a society. Different dimensions of vulnerability can also be considered. For example, in relation to agriculture, Reilly (1996) recognizes differences among sector vulnerability, regional economic vulnerability, and hunger vulnerability. Adger (1999) disaggregates social vulnerability into individual (or household) vulnerability and collective (i.e., national, regional, or community) vulnerability.

A number of efforts have been made to map vulnerability, largely in association with food security. Many of these efforts have used geographic information systems (GIS) to show the spatial distribution of various indicators. The World Food Programme (1996) outlines five approaches to mapping food-related vulnerability (Table 1). Though each of these approaches can be used to assess vulnerability to climate change, some are more appropriate to large-scale assessments, and others to localized assessments. In a study of climate vulnerability, Bohle et al. (1994) use three indicators to construct a food security index that illustrates differential vulnerabilities to climate change among countries. The indicators represent national food availability or shortages, household food poverty, and individual food deprivation. This vulnerability assessment serves as a point of departure for further analysis involving trends in vulnerable groups and risks associated with climate variability (Bohle et al., 1994).

3.1. Climate change — winners and losers

Climate has been increasingly recognized as one among many processes that influence vulnerability. To determine the winners and losers in climate change, both biophysical and social vulnerability should be taken into account. As Liverman (1994, p. 332) emphasizes: “... the most vulnerable people may not be in the most vulnerable places — poor people can live in productive biophysical environments and be vulnerable, and wealthy people can live in fragile physical environments and live relatively well”. This suggests that assessments of

Table 1
Five approaches to vulnerability assessments^a

- Use poverty as a proxy indicator of vulnerability to food insecurity, drawing on national data to identify the number and location of socioeconomic groups judged to be vulnerable;
- Carry out surveys to collect information directly related to vulnerability. These surveys can incorporate the notion of coping strategies and levels of entitlements;
- Identify important determinants of vulnerability to food insecurity to create a proxy indicator based on available data. (The strength of this approach is dependent upon the selection of different indicators and knowledge about the context in which the indicators are being used);
- Conduct a rapid rural appraisal;
- Make use of individuals with expertise related to the issues addressed, and with extensive knowledge of conditions throughout the country.

^aSource: The World Food Programme, 1996. WFP Vulnerability Mapping Guidelines. Web site: <http://www.wfp.it/vam/mapguide.htm>.

vulnerability should not be limited to developing countries or countries with precarious physical environments.

In any case, vulnerability to climate change is not exclusively related to poverty. Extreme climate events can impact the wealthy and poor alike, particularly in high-risk environments. For example, all owners of coastal properties are susceptible to storm surges, whether they are wealthy or poor. Although one could argue that the wealthy are more resilient to recovery through mechanisms such as insurance, it is likely that premiums in high-risk areas will become increasingly difficult to obtain if climate variability increases with climate change (Stix, 1996). Even if an area is not considered to be high-risk, extreme climatic events can inflict serious damages and render a sector or social group vulnerable. For example, the 1998 ice storm that hit Eastern Canada debilitated the maple sugar industry, and had enormous impacts on dairy farmers who lacked back-up generators (Kerry et al., 1999).

Numerous country studies have been conducted to identify how climate change might play out in particular regions or sectors within the context of existing environmental and socioeconomic conditions (Smith et al., 1998; O'Brien, 2000). The objective of these impact assessments is to measure the positive and negative consequences of short- or long-term climate change, and to evaluate different adaptation strategies that could be taken in response to the impacts. Within the assessment framework lies the goal of identifying climate sensitivities and vulnerabilities, with an emphasis on the regions, sectors, ecosystems and social groups within each country that are likely to be most affected by climate change (Parry and Carter, 1998).

In considering the linkages between climate change and socioeconomic conditions, Parry and Carter (1998, p. 24) note that "... the effects of any climate change in the future will be influenced by concurrent economic and social conditions and the extent to which these create a resiliency or vulnerability to impact from climate change". Nevertheless, most impact analyses consider only crude socioeconomic scenarios, developed from baseline scenarios representing "the present state of all

the non-environmental factors that influence the exposure unit" (Parry and Carter, 1998, p. 75). Most socioeconomic scenarios involve a simple extrapolation of present-day trends, such as population and economic growth rates. Often different trajectories are considered, including high-growth, low-growth, and "business as usual" scenarios.

Regardless of which socioeconomic scenario is used, there is generally little concern for how the patterns of social and economic development will change in an increasingly globalized economy. Changes in trade and investment patterns, combined with improvements in transportation and communications networks, are contributing to profound changes in local and regional economies. Furthermore, the process of globalization, like climatic change, is ongoing and will continue over time. Over the next 20–50 years (the time frame in which climate change impacts may be profoundly felt) the uneven spread of globalization will continue, and will likely accelerate. As a consequence, future patterns of development for many countries and regions may deviate substantially from past trends and the current development trajectory.

4. Economic globalization

Economic globalization describes a set of processes whereby production and consumption activities shift from the local or national scale to the global scale. Globalization is manifest through a number of interrelated changes, including rising levels of international trade, foreign investment, and multinational firm activity. It is also manifest through falling political barriers to trade and investment, integration of global financial markets, integration of production activities across international borders, development of global communication systems, and homogenization of demand for consumer goods across countries.

Frequently cited indicators of economic globalization include the growth in international trade and foreign direct investment relative to levels of economic output.

Between 1950 and the middle 1990s, world trade grew by a factor of 14, whereas world output increased by a factor of five (Dicken, 1997). Foreign direct investment (FDI) has also grown rapidly, particularly over the past several decades. Whereas world output has approximately doubled since 1970, FDI has quadrupled during the same period (Dicken, 1997).

Rising levels of trade and investment have been accompanied by important changes in the production process. Production in many industry sectors now occurs across international borders. In most cases, multinational firms are continuing to locate their headquarters and research and development facilities in their home country, but are increasingly able to shift lower-skill, lower wage components of the production process to other regions of the world. This proliferation of a global spatial division of labor has meant that a growing share, perhaps as much as one-third, of international trade now involves trade between subsidiaries of the same firm (Dicken, 1997).

Another key change associated with economic globalization involves the integration of world financial markets. As a result, countries have less control over their own currencies and macroeconomic policies. As noted by Epstein (1996, p. 211):

... financial capital moves around the globe at such an amazing speed that national governments seem helpless in its wake. Legislatures and citizens who want to buck the trend and achieve goals of high employment, egalitarian development and sustainable growth, are paralyzed by the threat that any policy which lowers the rate of profit will cause capital to be moved to more profitable environs, thereby reducing investment and lowering the community's standard of living.

A large literature has emerged to explain what accounts for globalization (e.g. (Boyer and Drache, 1996; Castells, 1996; Dicken, 1997; Greider, 1997; Harrison, 1994; Stalk and Hout, 1990). Important factors driving globalization include:

- technological changes, especially changes in communication and transportation technologies;
- changes in production processes involving both increased use of information technologies and a shift from large-scale, mass production to more flexible production methods; and
- changes in the nature and intensity of competition between firms as a result of the general slowdown in global economic growth since approximately 1970; growing international competition has pushed firms to broaden their search for new markets and cheaper production sites and has generated new types of cross-national inter-firm collaborative behavior.

While there is continuing debate over both the extent of globalization as well as the relative contributions of

various driving forces, there is general agreement that processes of globalization are ongoing and will continue well into the 21st century. For this reason, the social, economic and environmental impacts of globalization must be considered over the long term.

4.1. *Winners and losers from economic globalization*

Despite a widespread perception that globalization is a unifying and all-encompassing force, these processes have (heretofore) been highly uneven across all geographic scales. In fact, it has been argued that globalization accentuates, rather than erodes, national and regional differences (Mittelman, 1994).

Processes of globalization have been uneven among major regions of the world, characterized by an increasing proportion of trade and resource flows taking place both within and between between three major economic regions, including North America (US, Canada and Mexico), the European Union and East and Southeast Asia (led by Japan). These three regions, often referred as the Triad, accounted for 76% of world output and 71% of world trade in 1980 (Dicken, 1997). By 1994, the Triad accounted for 87% of world merchandise output and 80% of world merchandise exports (Dicken, 1997).

Increased concentration of global economic activity among the Triad has meant that large regions outside the Triad, particularly Sub-Saharan Africa and South Asia, have become increasingly marginalized vis a vis the global economy (Castells, 1996; Mittelman, 1994). Examination of the global distribution of foreign direct investment among low and middle income countries aptly illustrates these regional differences (Table 2). More than 10% of the world population currently lives in Sub-Saharan Africa, yet this region receives only 1% of total world foreign direct investment (World Bank, 1998). Similarly, South Asia contains 22% of the world population, but receives only 1.1% of world foreign direct investment (World Bank, 1998).

Globalization processes are also uneven among regions within countries (Hirst and Thompson, 1996). Within China, for example, coastal regions have been increasingly integrated into the global economy, while more remote areas of the country remain largely untouched by globalization. As a result, globalization is exacerbating existing patterns of uneven development within China. Even within an advanced country such as the United States, the impacts of globalization have been highly uneven. Studies of international trade involvement of US cities and regions by Markusen et al. (1991), Hayward and Erickson (1995) and Noponen et al. (1997), for example, find substantial variability in the level of involvement in international trade and in the relative contribution of international trade to regional economic growth.

Table 2
Regional distribution of foreign direct investment among low and middle income countries in 1996^a

	Foreign direct investment (millions)	FDI share of world total (%)	Population (millions)	Population share of world total (%)
World total	314,696	100.0	5755	100.0
East Asia and Pacific	58,681	18.6	1732	30.1
Europe and Central Asia	14,755	4.7	478	8.3
Latin America and Carib.	38,015	12.1	486	8.4
Middle East and N. Africa	614	0.2	277	4.9
South Asia	3439	1.1	1266	22.0
Sub-Saharan Africa	3271	1.0	596	10.3

^aSources: World Bank, 1998. *World Development Report 1998/1999: Knowledge for Development*. Washington, DC: World Bank; World Bank, 1998. *World Development Indicators 1998*. Washington, DC: World Bank.

As with climate change, the uneven nature of globalization leads to the emergence of winners and losers. In addition to globalization's frequently identified winners, which include large transnational corporations and advanced and newly industrializing countries (Cook and Kirkpatrick, 1997; Fischer, 1990; Greider, 1997), winners may also include subnational regions and social groups which benefit directly or indirectly from globalization (Tardanico and Rosenberg, 2000). Frequently identified losers in the process of globalization include countries of Sub-Saharan Africa, as noted above, as well as unionized labor and small, locally oriented firms (Conroy and Glasmeier, 1993). Additional losers may include other regions and groups that are left out of globalization processes or that experience direct negative impacts.

Like climate change vulnerability assessments, the identification of winners and losers in globalization is not strictly an advanced versus developing country issue. In analyzing the impacts of changing patterns of international trade for wages and employment within both advanced and developing countries, Wood (1994) identifies groups of both winners and losers within advanced ("North") and developing areas ("South"). Based on traditional theory of comparative advantage, Wood demonstrates that liberalization of trade benefits those factors of production that are relatively abundant in both the North and South, and harms factors that are relatively scarce in each region.

The example of NAFTA further illustrates how globalization results in new categories of winners and losers (Conroy and Glasmeier, 1993; Tardanico and Rosenberg, 2000). Conroy and Glasmeier (1993) identify some of the winners with NAFTA, including US workers in high technology and service-oriented industries, especially in large urban areas, as well as Great Plains farmers producing crops such as corn, sorghum and soybeans. Within Mexico, winners are identified as workers in low-skill manufacturing industries and farmers producing specialty crops for export. Losers within the US include workers in low-wage sectors, especially those located in

rural areas of the US South, such as textiles and apparel, and farmers in dairy, sugar and specialty fruit and vegetable sectors. Within Mexico, losers include workers in previously protected manufacturing industries and grain farmers located in rural areas throughout the country (Conroy and Glasmeier, 1993).

5. Double exposure

Both climate change and economic globalization are ongoing processes with uneven impacts, and both include implicit winners and losers. Nevertheless, discussions of winners and losers rarely take into account the fact that both processes are occurring simultaneously. To address this, we introduce the concept of double exposure. Double exposure refers to cases where a particular region, sector, ecosystem or social group is confronted by the impacts of both climate change and economic globalization. It recognizes that climate impacts are influenced not only by current socioeconomic trends, but also by structural economic changes that are reorganizing economic activities at the global scale.

The overlays between globalization and climate change impacts can be viewed from a regional perspective, a sectoral perspective, or with an emphasis on one or more social groups or ecosystems. In some cases, the consequences of globalization may offset the impacts of climate change, or vice versa. In other cases, exposure to both globalization and climate change may result in "double winners", or "double losers". The following examples illustrate the concept of double exposure, and show that different outcomes emerge when the two processes are considered together.

5.1. Regional perspectives

From a regional perspective, certain geographic areas may be strongly impacted by both globalization and climate change. As new trade and economic zones

emerge, other areas become peripheral or marginalized. Border regions or rural areas that undergo similar experiences related to climate change or globalization processes can be analyzed from a regional perspective. Clusters of countries that share common characteristics, such as economies in transition or semi-arid environments, can also be analyzed from a regional perspective.

Africa is often cited as a region that is vulnerable to both climate change and the consequences of economic globalization. In the case of Africa, it is the lack of globalization that is considered to be significant. Relative to many other areas of the world, most of the African continent remains “left out” of globalization processes (Agnew and Grant, 1997; Castells, 1998; Mittelman, 1994). Africa’s share of world trade represents only 1.8% of the total, and has been falling steadily in recent years (Dohman and Halvorson-Quevedo, 1997). Within Africa, only a handful of countries account for almost 60% of the region’s imports. Of these, South Africa has the most dynamic economy, accounting for 30% of the continent’s imports in 1995 (Hawkins, 1997). While foreign direct investments are contributing to growth and prosperity in some regions of the world, Africa is notable for its small share of FDI (see Table 2). The exclusion or marginalization of Africa in terms of globalization processes suggests that it is a loser relative to other regions.

From a climate change perspective, Africa can also be considered a loser. Approximately two-thirds of the continent is comprised of drylands, and considered to be highly vulnerable to climate change. Much of the continent is currently affected by interannual climate variability, with droughts or floods recurring frequently. Widespread poverty makes the continent more vulnerable to the impacts of projected changes because of limited adaptation capabilities (Watson et al., 1997). Increased temperatures and decreased precipitation, as suggested by some computer model results for Africa, could have a strong impact on the region’s agricultural sector. Agriculture accounts for 20–30% of GDP in sub-Saharan Africa, and contributes 55% of the total value of African exports (Watson et al., 1997). Environmental and health problems may also be exacerbated by climate change.

Although current conditions suggest that Africa is a “double loser” in terms of climate change and globalization, in reality the situation is more heterogeneous and dynamic. Some sectors or regions may experience benefits from climate change. For example, in areas where precipitation does not change, the fertilizer effect of increased CO₂ concentrations could benefit agriculture (Hulme, 1996). The impacts of globalization are also likely to change over time. In fact, most African countries are currently seeking to globalize and open the door to foreign investment through liberalization of trade and payments regimes. Although small in comparison to other regions, foreign investment increased from \$1.7

billion in 1993 to \$5 billion in 1996 (Hawkins, 1997). These investments have differential impacts on the 53 countries in Africa, and on sub-regions and social groups within each country. For this reason, it is useful to consider multiple perspectives when assessing winners and losers associated with economic globalization and climate change.

5.2. Sectoral perspectives

Both climate change and economic globalization will have varying consequences for different sectors of the economy. Certain sectors are considered to be at the forefront of globalization activities. These include the communications and electronics industries, but also resource-based sectors, such as agriculture and forestry. Agriculture provides a vivid example of double exposure and the convergence of impacts related to climate change and economic globalization. To illustrate, we will focus on the case of agriculture in Mexico.

The opening of Mexico’s economy through liberalized trade and deregulation of markets has had a number of important implications for agricultural production (Bonnis and Legg, 1997). In Mexico, agriculture is important to approximately 30% of the country’s population. Over the past decade, Mexican agriculture has become increasingly integrated into the global food market, especially within the North American region (Gates, 1996). Under the “comparative advantage” argument associated with liberalized trade, Mexico is seen to have a competitive advantage in the production of horticultural crops, particularly winter vegetables for export markets in the North. With less protectionism, prices are increasingly dictated by international markets, and farmers are forced to compete with imports, particularly for basic grains (Barry, 1995; Hewitt de Alcantara, 1994).

Who are the winners and losers in terms of globalization of the agricultural sector? According to Kay (1997, p. 19), “the beneficiaries are a heterogeneous group, including agro-industrialists, capitalist farmers, and some capitalized peasant households. The losers are the semi- and fully proletarianized peasantry, the majority of rural labourers whose employment conditions have become temporary, precarious and ‘flexible’”. Although agro-industrial modernization has benefited a small part of the rural population, for the most part small farmers in Mexico have been excluded from the benefits of globalization (Cornelius and Myhre, 1998; de Janvry et al., 1997).

Mexico can also be considered very sensitive to climate variability and change. Of Mexico’s 195 million hectares of land, 85% is considered semi-arid, arid, or very arid, with climates characterized by low, seasonal and highly variable rainfall. Only about 16% of Mexico’s land is considered to be suitable for crop production (Appendini and Liverman, 1994). Furthermore, the country’s rainfall

is disproportionately concentrated in the south. As a result, much of Mexico is affected by climate variability, especially droughts. The severe droughts, fires and floods of 1998 provide some examples of the enormous economic and social consequences of climate variability. Global climate change is likely to make some parts of the country hotter and drier than at present, and possibly increase climate variability (Liverman and O'Brien, 1992).

A greater emphasis on the production of water-intensive fruit and vegetable crops for the export markets means that this specialized sector is vulnerable not only to price fluctuations on international markets, but also to climate variability and change (Appendini and Liverman, 1994). Rural labor markets have also been transformed by the expansion of export agriculture. The transformation has been characterized by the growth of temporary and seasonal wage labor, which is dictated by the flexible needs of producers. Climate change is likely to increase the supply of wage labor, as more farmers are driven from production on marginal lands. It could also lead to a reduced demand for labor on agro-industrial farms during years with severe weather. Farmers who are trying to compete in these international markets as well as agricultural wage laborers in Mexico are thus likely to be double losers in terms of climate change and globalization.

5.3. *Social group perspectives*

The example cited above suggests that it is important to consider the social consequences of globalization and climate change, even within a sectoral analysis. Within Mexico's agricultural sector, farmers who cultivate marginal, rainfed lands are more vulnerable than those with access to the most productive lands (Liverman, 1990). Adaptation measures, such as improved seeds, fertilizers and irrigation treatments, are often not options for small farmers. For instance, many adaptation measures require access to credit, which is not evenly available to all producers (Myhre, 1994).

Examples of other social groups that are double exposed to globalization and climate change include poor residents of large cities in advanced and developing countries. Within the United States, for example, processes of globalization have reduced both demand and wages for low-skilled workers, and have contributed to rising levels of urban income inequality and increased the spatial concentration of poverty within central city areas (Castells, 1998; Jargowsky, 1997).

At the same time that globalization is contributing to the economic vulnerability of disadvantaged residents of US cities, climate change may increase the physical vulnerability of these groups to weather-related events. Climate change may increase mean summer temperatures in Northern cities, and may also increase the

frequency and magnitude of summer heat waves, consequently increasing heat-related illnesses and deaths (Stone, 1995). Residents of poor, inner-city communities are among the most vulnerable to heat waves due to lack of resources to pay for air conditioning or to leave stifling central city areas. In the case of the Chicago heat wave of 1995, for example, most of the more than 700 deaths occurred among poor and elderly residents of inner city areas. Other large US cities, such as New York, St. Louis, and Los Angeles are also expected to experience increases in summer heat-related mortality as the result of global warming (Stone, 1995), and the impacts will likely fall disproportionately on poor, inner city residents. Globalization and climate change thus represent a dual threat to these groups.

For poor residents of cities in the developing world, the double impacts of globalization and climate change may be even more severe. Economic globalization increases the vulnerability of the urban poor to income and employment disruptions as the result of precipitous currency movements and shifts in global financial capital. The recent devaluation of the Brazilian real, for example, had substantial impacts on livelihood of shantytown — or *favela* — residents in the Brazilian city of Belo Horizonte, many of whom have moved into the consumer economy from a subsistence one since 1994 (Wall Street Journal, 1999). The Brazilian currency devaluation has had the most severe impacts on the poor, who spend the bulk of their income on basic goods and who typically are unable to shield their financial assets in interest-bearing bank accounts. In the case of the recent devaluation, prices of many basic foodstuffs increased by nearly 30% (Wall Street Journal, 1999).

In conjunction with increased financial vulnerability as the result of globalization, poor residents of developing world cities are also among the groups that are most vulnerable to climatic change. Many of the urban poor live in shantytowns and squatter settlements located in precarious areas such as on hillsides, as in the case with the favela residents of Belo Horizonte, or in flood plains. Such areas are especially vulnerable to mudslides or flooding as the result of severe storms, events that may increase in both frequency and magnitude as the result of climate change. In addition to direct physical hazards, the urban poor are also vulnerable to climate change related health-hazards, particularly outbreaks of diseases such as cholera and malaria, both of which increase with warm spells and heavy rains (Stone, 1995). In considering the potential impacts and adaptations to climate change and globalization, the special needs of different types social groups must be taken into account.

5.4. *Ecosystem perspectives*

Natural ecosystems considered vulnerable to climate change may also be affected by economic globalization,

particularly as economic activity becomes more concentrated in certain areas, such as coastal zones. Economic globalization may also lead to the restructuring or demise of local industries, such as fisheries or forestry. Consequently, the biospherical impacts of climate change may be exacerbated by an expansion of economic activity, or they may be reduced by the alleviation of anthropogenic influences, brought about through local economic changes.

For example, in China, investment flows and other trends associated with economic globalization have been focused on coastal ecosystems. In contrast, the western region of the country has lagged behind in terms of exports and participation in international markets (Mittelman, 1994; Sun and Dutta, 1997). Four special economic zones (SEZs) were established in coastal areas in 1979, when the country moved from a product-based economy to a market economy. In 1984, 14 coastal cities were opened to foreign investment. The coastal region now has a much better transportation and communications infrastructure than inland regions of China, and has since then received more foreign direct investment and generated larger exports. Between 1983 and 1993, 89.7% of China's FDI was directed to the coastal region, whereas only 6.9% and 3.4% was located in the central inland and western inland regions (Sun and Dutta, 1997). Even though the coastal region may be considered a winner from a globalization perspective, the impacts of increased economic activity (e.g. pollution, loss of wetlands) are generally considered negative from an ecosystem perspective.

Coastal areas are also among the most vulnerable to climatic change. In addition to the possibility of inundation as a result of sea level rise, climatic change will also increase risks of flooding and erosion due to storm surges and increased runoff (Handley, 1992; Watson et al., 1996). In the case of China, the IPCC estimates that approximately 70 million people living in the coastal region will be affected by climatic change (Watson et al., 1997). In addition to threats to China's population centers, sea-level rise and increased storm surges may also damage coastal fisheries and low-lying rice farms throughout the region. In light of globalization-related development trends and the increasing importance of coastal areas for the Chinese economy as a whole, climatic change may have severe economic impacts. From an ecosystem perspective, coastal areas of China are thus likely to experience the negative consequences of both economic globalization and climate change.

6. Issues and questions for future research

The examples above illustrate how the concept of "double exposure" can be approached from various perspectives. Climate change is likely to have differential

impacts among regions, sectors, social groups and ecosystems. In some cases, the changes will be beneficial, whereas in other cases, they will cause major economic, social, and environmental disruptions. Likewise, as certain regions, sectors or social groups take advantage of opportunities associated with globalization, others are left out or forced to absorb the negative impacts. By superimposing the effects of globalization on the regions, sectors, social groups, and ecosystems that are vulnerable to climate change (as well as on those that may benefit from climate change), a new set of winners and losers emerges.

There is clearly a need for further research related to the concept of double exposure. Most of the current studies of climate change and economic globalization have examined the two processes in isolation from each other. Although there has been a growing interest in the relationship between globalization and the environment, the majority of studies in this area focus on causal linkages, rather than double exposure. Yet as we have discussed in this paper, there are winners and losers associated with both processes. Given potential synergisms between the different sets of winners and losers, the two processes should be considered together.

The notion of winners and losers can be used as a framework for examining the impacts of climate change and economic globalization. However, there is a need to address some of the questions posed earlier about "winners" and "losers" within the context of climate change and globalization research. In particular, it is necessary to elaborate how (or if) wins and losses can be objectively and reliably identified and measured. Issues surrounding the scale of analysis must also be explicitly addressed, as subsets of winners and losers are often merged in aggregated analyses.

Different perspectives can be adopted when examining globalization and climate change, including regional, sectoral, social group and ecosystem perspectives. The examples described above demonstrate that a winner from one perspective is not necessarily a winner from other perspectives. Although case studies may serve as a useful means for examining double exposure to climate change and economic globalization, the implications of different perspectives should be acknowledged.

From a policy standpoint, the regions, sectors, social groups, or ecosystems that are adversely affected by both globalization and climate change should be of particular concern, as these "double losers" are likely to emerge as challenges to both processes. In terms of climate change, adaptation strategies may be counteracted or rendered ineffective by outcomes associated with economic globalization. For example, in agriculture, attempts by small-scale farmers to adopt drought-tolerant seeds in response to drier conditions may be hindered by the more restrictive access to credit associated with economic liberalization policies. In terms of globalization, efforts to re-train labor or reorient economic activities to adjust to the

global economy may be frustrated by the impacts of climate change and variability. This could be a particular problem in regions facing increasing water scarcity.

The potential for double losers raises some important research questions: To what extent are the losers in climate change also the losers when it comes to economic globalization? Is resilience to economic restructuring related to resilience to climate variability and change? What are the links between adaptations to the new global economy and adaptation of strategies to address long-term climate change? These questions can be addressed within the research framework described above.

In terms of methodology, there is a need for both qualitative and quantitative analyses of double exposure. Qualitative studies can be based on individual case studies or comparative studies that examine the impacts of climate change and economic globalization together, from one or more of the perspectives mentioned above. Quantitative studies that make use of economic and social statistics can be combined with the results generated from climate simulation models to identify regions or social groups that are vulnerable to both processes. As in vulnerability analyses, proxy indicators can be developed to highlight the differential consequences of climate change and economic globalization across regions, sectors, or social groups. Geographical information systems (GIS) can serve as a useful tool for integrating climate impacts with globalization impacts, so that the outcome of the two processes can be analyzed together, and at a number of spatial scales.

Processes of climate change and economic globalization are complex, uncertain, and to a large extent inevitable. Both processes will have winners and losers, which in turn will have important implications for economic development strategies in the 21st century, as well as for climate change adaptation policies in both developed and developing countries. By focusing on the concept of double exposure, this paper has outlined an approach by which the joint impacts of these processes can be better understood.

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