CHAPTER 8

THE ECONOMIC IMPACT OF CLIMATE CHANGE ON THE NEW ENGLAND REGION

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This chapter describes an initial effort to evaluate the nature of cause and effect impacts of climate change on the economy of the New England Region (including upstate New York[1]). The economic impacts on three segments of the regional economy were examined on a state-by-state basis. The three segments are natural resources, tourism, and health care. Climatic changes can have impacts on the economy through myriad cause and effect chains. One such cause/effect chain was examined in detail: the potential consequences of regional climate change on fall foliage-related tourism.

Due to the narrow scope of this initial assessment, it must be seen as only the first in a series of steps needed to fully understand the true economic impacts of climate change on the region. It is important to note that this initial effort has highlighted the complexity of the problem. Due to limitations in availability of appropriate data, the present study does not provide a quantitative assessment of any of the segments considered.

Four "links" are identified in a chain of potential impacts stemming from potential climate changes to eventual economic impacts. This chapter focuses on summarizing the implications of what is known about the latter two links in Figure 8.1, with a particular emphasis on the last link: economic impacts of behavioral changes. The Inplan Economic model was used in this initial analysis.

Summary of Key Findings

The major conclusion from this initial analysis is that while each of these segments of the economy are important to the people of the region in *absolute* terms, it is not possible to quantify their economic impact on regional economic activity. Thus, the natural resources sectors employ roughly 100,000 people in New England plus upstate New York, where they pay roughly $630 million in wages and compensation (in 1996 dollars); the split between New England and upstate New York is roughly 50% each. Tourism employs 250,000 New Englanders and another 106,000 upstate New Yorkers, paying total wages of greater than $6 billion. Finally, Health Care employs 650,000 people in New England alone, where it pays in excess of $20 billion in wages and compensation. Converting these absolute figures into meaningful economic impacts is not presently possible due to the high levels of uncertainties regarding the full impact of climate change on each of these segments. As will be seen in the detailed assessment of such impacts on fall-foliage tourism, appropriate datasets on fall tourism are not readily available.

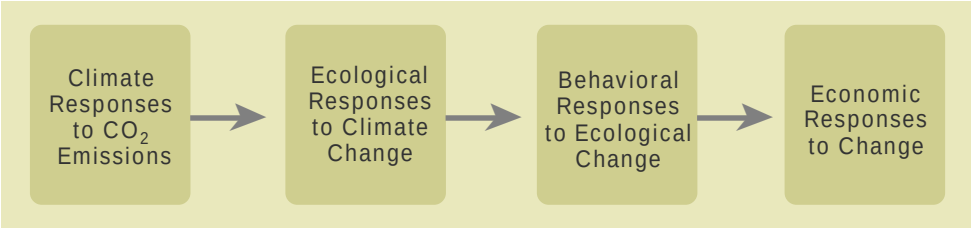

FIGURE 8.1 Links in the impact chain from greenhouse gases to the economy.

[1] Upstate New York is defined herein as consisting of all of the state of New York except the following predominantly urban counties which are in the immediate vicinity of New York city: Nassau, Suffolk, Kings, Queens, New York (county), Bronx, Rockland, Westchester, Orange, and Putnam.

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In terms of the regional economy, the health care segment (comprised of the sectors "Hospitals, Doctors and Dentists", and "Nursing and Protective Care") accounts for the largest share, over 9% of total employee compensation (wages plus benefits) in the New England Region, with state-level shares ranging from 8.7% in New Hampshire to 11% in Rhode Island. The U.S. average share of total employee compensation for this segment is 7.7%. This high level of importance means that a large disturbance to this sector would have a significant impact on the regional economy. Identifying the appropriate multipliers needed to convert a significant disturbance into a realistic economic impact has not been possible.

Next in economic importance is tourism. Because some of the output from this segment serves local consumption, we first extract only that portion of activity in tourist-related industries which serve visitors to the states. Tourism-related shares of these industry's output range from lows of 7-30% for general retail, to in excess of 50% for lodging and for non-auto transportation. This direct tourist impact accounts for just over 3% of total New England Regional economic activity, and 3% of employment. Tourism's shares are highest in Vermont, exceeding 5% of employment there. Note that because these industries tend to pay lower than average wages, they account for smaller shares of total employee compensation (1.6% in the region, and 3% in Vermont). Again, determining the appropriate multipliers has yet to be done.

Two obvious ways that climate change might impact New England's tourism are impacts on the ski industry and fall foliage-related tourism. Economic databases and models used for this analysis classify the ski industry as part of the sector "Amusement and recreation services, not elsewhere classified." New economic models will need to be modified in order to identify and quantify the ski industry contributions to regional tourism. Out-of-state spending in this category accounts for just under 1% of Vermont's economic output, but generally under half a percent of the economic output for the remaining states in the region. So the ski industry, while important for those directly involved, does not account for a major share of the regional economy, based on this nonspecific classification in the Inplan model.

The state offices of tourism in the region provided information indicating that fall foliage-related tourism accounts for approximately 20-25% of total annual tourism in Vermont and Maine. However, calculating the potential total regional economic impact of a climate-induced loss of maples and subsequent loss of foliage-related tourism is complex. The regional economic importance of tourism, combined with an economic model of tourism impacts on all other sectors due to economic linkages, indicate that for every $1 spent on tourism, roughly 20-60 cents of additional economic activity is generated elsewhere in the state. Note, too, that this multiplier-based modeling of economic linkages does not account for the "synergistic" effects among tourism-related industries, when, for example, visitors to ski slopes also stay in hotels and eat in restaurants.

Taken together, these results make it possible to estimate that a 50% reduction in fall tourism could account for up to a 1% drop in Vermont employment, with smaller impacts in other states and for other economic measures such as output and wages. Such impacts are important in an

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absolute sense, since the total region's tourism employs over 350,000 people. A 50% drop in fall tourism could correspond to nearly 20,000 jobs lost if fall tourism accounts for just 10% of the region's total, which is a conservative estimate.

Finally, of the economic segments considered, the natural resource-related industries account for the smallest share of the regional economies. With 1995 sales of 2.9 billion dollars in New England and 2.8 billion in upstate New York, this segment's output accounts for 2% of total economic output in Vermont, 1.6% in Maine, but under 1% for New England as a whole, and roughly 1% for upstate New York. Shares of total natural resources employment are slightly higher, while those for employee compensation are lower, reflecting lower-than-average wages for this segment.

Taken as a whole, these results point to the following general conclusions about assessing the potential economic importance of potential climate change impacts on the region. First, we note that Vermont, and to a lesser extent Maine, appear to lead the region in terms of the relative importance of both tourism and natural resource related industries. In Vermont, tourism-related spending accounts for 5% of the economy, and natural resources 2%. Thus, direct spending of $1 million in those sectors generally stimulates an additional $200K - $500K of economy-wide output in the same state. Region-wide economic impacts of specific climate-induced impact scenarios (e.g., skiing or foliage-related tourism) on both of these segments would be profound for those persons, companies, towns and sub-state regions directly involved.

A final conclusion is that due to the complexity of the economic assessment process, a thorough analysis is beyond the scope of the present New England Regional Assessment. Developing a regionally-specific economic model will be necessary to fully quantify climate change impacts to the region.

Full Impact Chain Example: Fall Foliage-Related Tourism

Of particular significance to this initial investigation is the fact that although potential "climate change" is sometimes imagined to be a single result, it is instead a highly multi-faceted phenomenon involving changes in both physical climate (temperature, precipitation) and chemical climate (air quality and acidic precipitation), both of which may have profound impacts on the forests of the New England Region. A variety of climatic impacts are relevant to the potential response of forest ecosystems to climate change. A simplified view of important causal relationships is presented in Figure 8.2.

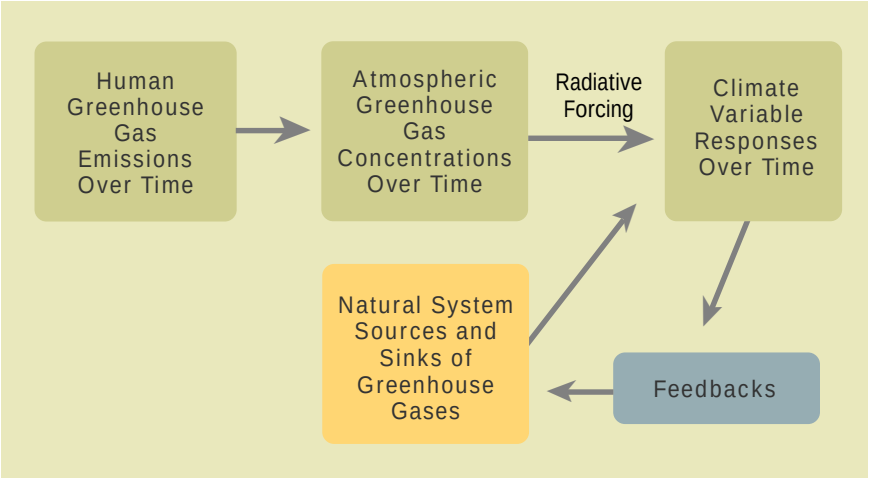

FIGURE 8.2 Schematic of climate response linkages.

The potential impacts of climate change upon fall foliage-related tourism relies on the responses of individual tree species.

Forest Responses to Climate Change

The potential impacts of climate change upon fall foliage-related tourism relies on the responses of individual tree species. The most vibrant fall foliage is displayed by the red maple and sugar maple; it is the relative abundance of these two species, interspersed with evergreens, which makes the New England Region such a popular destination for tourists pursuing fall foliage displays.

A recent study examines the influence of climatic factors upon the relative abundance of 80 individual tree species at a regional level within the Eastern U.S. Their hierarchical "regression tree" models draw from among 33 separate explanatory variables within four categories, as summarized in Figure 8.3.

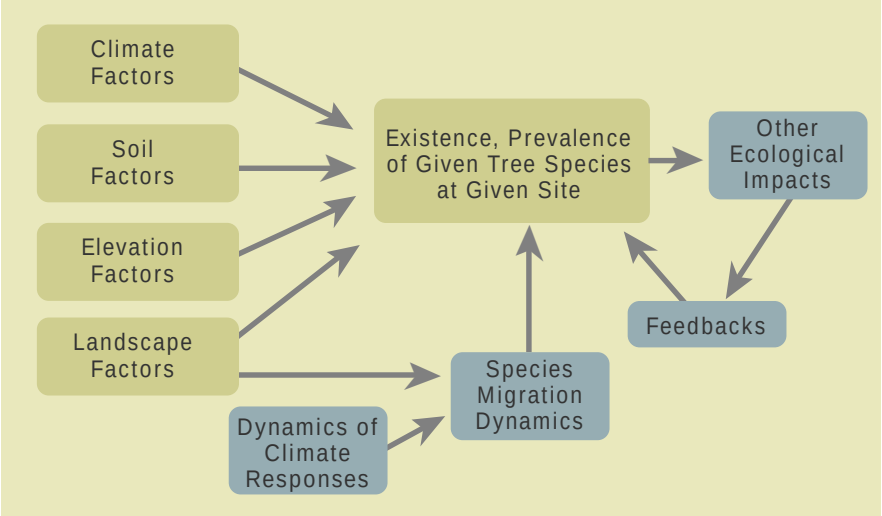

FIGURE 8.3 Schematic of forest response linkages (blue indicates additional factors which may be important but are not included in the initial 1998 model by Iverson and Prasad)

The study uses the models together with regional interpolations of global circulaton model-based projections of future equilibrium climatic responses to a doubled global atmospheric concentration of CO_2, in order to develop regionalized projections of the physical climate's potential impacts upon the abundance of individual tree species at a regional level in the Eastern U.S. (see Case Study 4 in Chapter 5). The model takes into account the influence of soil factors, climate factors, elevation and landscape factors upon the prevalence of species (Figure 8.3), as well as factors that may also be important in governing the actual regional response of tree species to climate changes, but which are not included in the model. These other factors include the *dynamics* of changes to climate (both physical and chemical), the dynamics of species migration, and interactions with other living elements of the ecosystem.

It must be emphasized that large uncertainties surround many facets of this modeling, including:

- the response of regional temperatures and precipitation to changes in atmospheric concentrations of greenhouse gases;
- the dynamics of climate response in relation to regional factors influencing climate (i.e., topography, coastal effects, etc.) and their interaction with the dynamics of species migration;
- the influence of human forest management practices over the coming century;
- the influence of other factors such as chemical climate impacts missing from the tree response model, and the uncertainties in the estimated values for the parameters that were included.

Only one state, Maine, was able to provide any information related to the factors that could influence visitors' decisions to undertake travel from out-of-state.

Thus, the model results should be looked upon as illustrative of the best sort of currently available scientific model-based results concerning foliage-relevant tree species responses to climate changes in our region, but not as *forecasts* of what will happen.

Tourist Behavior Responses to Forest Change

The uncertainties influencing this investigation do not end with environmental modeling, however. The next link in the overall impact chain (Figure 8.1) is the response of tourists to changes in foliage displays, and this link has even greater uncertainties because social, cultural, and emotional judgements must be considered.

Representatives at each of the seven states' offices of tourism were contacted, and asked for information concerning the factors that influence the decisions of fall tourists, as well as the importance of fall foliage-related tourism in their overall tourism market. Only two states were able to provide estimates of the relative significance of fall tourism within annual tourism totals. Vermont reported that 22% of its tourism occurs during the fall season, and Maine reported fall's share at 20%. It is interesting to note that only two of the seven states in the region were able to provide such data.

The following illustrates the very limited amount of relevant data that are readily available for use in an economic analysis. Only one state, Maine, was able to provide any information related to the factors that could influence visitors' decisions to undertake travel from out-of-state. The Maine Office of Tourism provided a detailed report written for that office by Longwoods International, a research consulting firm for the travel industry. The report did not address the fall tourism season directly, nor did it present results separately for visitors of different seasons, unfortunately. Results indicated that the most important reasons for visiting Maine, as cited by visitors who came for reasons other than business or visiting friends and family ("marketable tourism"), were:

- to tour the state (37%)
- to enjoy the outdoors (23%)
- to attend a special event (12%)
- for a beach vacation (9%).

Thus, the top two reasons for visiting (touring, and enjoying the outdoors) do have a strong *potential* connection to fall foliage for a significant percentage of visitors. Among three categories cited as of particular interest on trips by overnight "marketable" visitors, "eco-tourism" was cited by 20% of visitors, ahead of "historic tourism" (18%) and "cultural tourism" (12%). Sight-seeing was rated highly by 58% of marketable visitors to Maine, and within this category, "beautiful scenery" ranked highest among 13 aspects of sight-seeing, being cited 90% of the time.

These survey results do not enable us to estimate what portion of fall tourism might respond negatively to a reduction in fall foliage. They certainly do not make it possible to estimate what the reduction in tourism spending could be if foliage brilliance was no longer an attraction. The results do confirm, however, that beautiful outdoor scenery is among the most important reason that visitors come to Maine. This, together with the cited shares of annual tourism occurring in the fall

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(20% for Maine and 22% for Vermont) indicates that significant impacts on tourism from a climate-induced regional loss of maples would be expected. More detailed state-level data on fall tourism and its ties to foliar displays are needed before we can estimate in detail the impacts at the regional level of a loss of foliage-related tourism on the regional economy.

Economic Impacts of Tourist Behavior Changes

The final link in the impact chain concerns the consequences of changes in tourism for the wider regional economy. The way that tourism impacts the regional economy is through expenditures by tourists. These expenditures in turn can stimulate **direct, indirect,** and **induced** impacts.

Direct impacts include the revenues taken in, employment provided, and wages paid by the industries where tourists spend money directly. These industries include lodging, food service, entertainment, general retail, and transportation.

Indirect impacts occur as a result of expenditures by the directly impacted industries. For example, tourist spending on the lodging industry stimulates spending *by* the lodging industry on the goods and services of other sectors of the economy. These secondary purchases stimulate tertiary expenditures, and so on. Finally, induced impacts refer to the impacts generated by the spending activity of persons who are employed by the directly-impacted industries – namely, the "tourism" industries.

Data characterizing direct, state-level travel-related expenditures in 1996, as reported by the Travel Industry Association (TIA) in a recent research report are provided in Table 8.1a, for the New England states and upstate New York[2]. Table 8.1b shows the total wages paid by each sector in each state in 1996. Finally, Table 8.1c provides estimates of the number of jobs (full-time equivalents) associated with these tourism sectors.

($M 1996)	Public Transport	Auto Transport	Lodging	Food Service	Entertainment/ Recreation	General Retail
Upstate NY	1614	1444	2609	2678	318	1368
Connecticut	1917	495	582	752	210	298
Rhode Island	351	150	151	150	52	67
Massachusetts	3731	1112	2081	1807	583	885
Vermont	172	135	305	363	188	153
New Hampshire	671	205	294	355	172	150
Maine	393	321	367	455	150	202

TABLE 8.1a Direct state-level travel-related expenditures in 1996 (source: TIA 1999).

[2] The TIA data pertains to the entire state of New York, including the NYC metropolitan area. Here we have adjusted the TIA's figures to estimate only those expenditures occurring in upstate New York. See the discussion in section 3 of this chapter for more details.

Indirect and induced impacts of tourism are estimable using economic impact assessment models, such as input/output models.

($M 1996)	Public Transport	Auto Transport	Lodging	Food Service	Entertainment/ Recreation	General Retail
Upstate NY	583	112	615	722	143	192
Connecticut	189	43	151	213	109	53
Rhode Island	34	11	38	40	20	11
Massachusetts	653	91	591	522	281	133
Vermont	20	10	98	89	21	24
New Hampshire	47	16	84	90	53	21
Maine	35	19	91	117	49	30

TABLE 8.1b Direct state-level travel-related payroll in 1996 (source: TIA 1999).

(thousands of jobs)	Public Transport	Auto Transport	Lodging	Food Service	Entertainment/ Recreation	General Retail
Upstate NY	15	5.3	27	57	5.2	10
Connecticut	5.6	1.6	8.5	18.0	5.0	2.7
Rhode Island	1.1	0.5	2.4	4.0	1.3	0.6
Massachusetts	18.0	3.9	29.7	42.9	14.2	7.3
Vermont	0.8	0.6	6.8	9.0	1.5	0.5
New Hampshire	1.3	0.8	6.1	8.8	3.8	1.2
Maine	1.7	1.0	7.4	12.1	4.3	1.9

TABLE 8.1c Direct state-level travel-related employment in 1996 (source: TIA 1999).

Industry	Value of output stimulated (thousand $) by $1 million of hotel & lodging industry business
Real Estate Agents	53
Credit Agencies	48
Other Non-Farm Buildings	40
Electric Utilities	40
Wholesale Trade	34
Gas Utilities	27
Management Consulting Services	27
Communications except Radio and TV	26.3
Advertising	25.7
Miscellaneous Plastic Products	24
Banking	22
Personnel Supply Services	17
Auto Rental and Leasing	16
Crude Petroleum	16
Hotels and Lodging Places	3
Total, all sectors of the economy, not limited to those listed above	886

TABLE 8.2 Output in other industries induced by $1 million activity by hotel and lodging.

Indirect and induced impacts of tourism are estimable using economic impact assessment models, such as input/output models. Economic input/output models make use of data on the purchases made by each sector for the goods and services from all other sectors. The most detailed input/output tables in the USA are all based on the results of the U.S. Department of Commerce's Bureau of Economic Analysis (BEA). As an example of indirect impacts stemming from direct tourism expenditures, Table 8.2 presents the total amount of indirect economic output stimulated by the hotel and lodging industry, per million dollars of output from that industry. Table 8.2 also presents results for the top industries whose output is stimulated by the purchases of the hotel and lodging industry.

Because of all the uncertainties involved at every step in the impact chain, it is not possible to make “forecasts” of climate change’s true economic impacts for any scenario.

As Table 8.2 shows, the economic impacts of tourism extend beyond the tourism industry, to include industries such as real estate agents, banks, construction, utilities, advertising, etc. A significant share of this sort of indirect impact (and of the induced impacts as well) would occur in the same region as the direct impacts.

Data Gaps and Information Needs

Of the many data gaps, one important missing piece of data needed for estimating foliage-related tourism in the region was the share of total sales due to foliage-based tourism, for all states. Maine and Vermont were the only states which reported seasonal shares of tourism-related spending, and the fall season share includes some spending not tied to foliage. Even in these states, specific details related to fall foliar tourism are not available. The same is true for specific economic information on ski-related tourism where data are not available by state or for the region.

More broadly, any economic analysis relies on a chain of effects for the various causal links between climate changes and their economic impacts, and each link in this chain is modeled with a significant degree of uncertainty. As our understanding of these connections, and the inherent uncertainties improves, our ability to project economic impacts resulting from climate change will improve. Nevertheless, the current state-of-knowledge has allowed order-of-magnitude insights into the potential scale and nature of economic impacts of climate change for the region.

Conclusions

This final chapter has investigated the multiple facets of the total chain of impacts which would extend from climate change through to economic impacts of such change. The potential for economic impacts of climate change have been considered for the health, tourism and natural resources segments. In addition, a specific scenario has been studied in depth: the impacts of climate change upon fall foliage-related tourism in New England and New York.

Because of all the uncertainties involved at every step in the impact chain, it is not possible to make “forecasts” of climate change’s true economic impacts for any scenario. It has been possible, however, to illustrate that the causal linkages between climate change and the region’s economies are real, and to illustrate the current levels of information available, the modeling approaches which characterize each of these linkages for a particular scenario of potential consequence for the region, and the significant data gaps that must be filled before a more quantitative analysis can be conducted.

It is clear that the types of climate change projected by the climate models used in this assessment would have profound impacts on many segments of the region’s economy. While these impacts are significant, this initial effort does not provide hard numbers regarding the potential economic impacts. For this, a regionally-specific economic model must be developed and applied.