Climate Change in the European Alps: Adapting Winter Tourism and Natural Hazards Management. OECD (2007), Executive Summary, p.1-4.

Executive Summary

This report provides an assessment of the impacts of, and adaptation to, climate change in the areas of winter tourism and natural hazards management for the European Alps.[1] The implications of this assessment however extend beyond the European Alps. Insights into the costs of adaptation, the roles of the private sector and government agencies, and broader lessons on the synergies and trade-offs between climate change adaptation and other sectoral and development priorities are also likely to be relevant for other mountain systems which face similar climatic and contextual challenges, for example in North America, Australia and New Zealand. More generally, examining the case of the European Alps – where there is high adaptive capacity – can highlight examples of good adaptation practices and the role of financial mechanisms, as well as identify constraints and limits to adaptation. Such insights would be valuable not only for other developed country contexts, but for developing countries as well.

Climate change is already affecting the European Alps, and adaptation is of vital importance

The Alps are particularly sensitive to climate change, and recent warming has been roughly three times the global average. The years 1994, 2000, 2002, and particularly 2003 have been the warmest on record in the Alps in the past 500 years. Climate models project even greater changes in the coming decades, including a reduction in snow cover at lower altitudes, receding glaciers and melting permafrost at higher altitudes, and changes in temperature and precipitation extremes. These climatic changes are impacting a system that is not only of critical economic and ecological importance, but one which is also already vulnerable to a wide range of natural hazards as well as demographic and environmental pressures. The viability of measures to adapt to the impacts of climate change is therefore of critical importance for Alpine countries. This has been recognised by the Alpine Convention, which in late 2006 invited member countries to develop adaptation strategies promptly for the most affected sectors. Alongside, a recent Europe-wide assessment has identified increasing losses in winter tourism due to reduced snow cover and the increased exposure of settlements and infrastructure to natural hazards as the primary vulnerabilities to climate change in the Alps. These two sectors are therefore the focus of this in-depth analysis.

Winter tourism is particularly vulnerable, but sensitivity to climate change varies across the Alpine arc

Under present climate conditions, 609 out of the 666 (or 91%) Alpine ski areas in Austria, France, Germany, Italy, and Switzerland can be considered as naturally snow-reliable. The remaining 9% are already operating under marginal conditions. The number of naturally snow-reliable areas would drop to 500 under 1 °C, to 404 under 2 °C, and to 202 under a 4 °C warming of climate. This is the first systematic cross-country analysis of snow-reliability under climate change for the Alps and covers more than 80% of the skiing domain. While the precise numbers are a function of the assumptions made, it is the overall trend as well as the spatial heterogeneity in the impacts which are of policy relevance. Sensitivity to climate change varies markedly among the Alpine countries. Germany is most sensitive, with only a 1 °C warming leading to a 60% decrease (relative to present) in the number of naturally snow-reliable ski areas. Practically none of the ski areas in Germany will be left naturally snow-reliable under a 4 °C warming. Switzerland, meanwhile, is the least sensitive of the five countries, with a 1 °C warming leading to only a 10% decrease, while a 4 °C warming would lead to a 50% decrease (relative to present) in the number of naturally snow-reliable areas. There will also be "winners" and "losers", both in terms of regions – for example Alpes Maritimes, Styria, and Friuli-Venezia-Giulia are considerably more vulnerable than Grisons, Valais, and Savoie – and in terms of the ski areas themselves, with low-lying ski areas being considerably more vulnerable than areas with high altitudinal range.

[1] The Alps include five OECD Members (France, Switzerland, Italy, Austria, and Germany) as well as Monaco, Lichtenstein and Slovenia.

The winter tourism industry is already adapting to climate change, but there are costs and limits

The winter tourism industry has responded to the implications of observed changes, and a range of technological and behavioural adaptation measures have been put into practice. Artificial snow-making remains the dominant adaptation strategy. Other measures include grooming of ski slopes, moving ski areas to higher altitudes and glaciers, protecting against glacier melt with white plastic sheets, diversification of tourism revenues, and the use of insurance and weather derivatives. Adaptation measures also have costs, as well as limits. Snow-making has proven cost-effective, but such estimates are based only on the direct financial costs to ski operations and do not include the potential externalities of such practices on water consumption, energy demand, landscape, or ecology. Furthermore, snow-making costs will increase non-linearly as temperatures increase – and if ambient temperatures increase beyond a certain threshold snow-making will simply not be viable. Likewise, grooming of ski slopes can reduce the minimum snow-depth required for ski operations by 10 or 20 cm. However, no amount of grooming can overcome significant declines or the total absence of snow cover. Similarly, plastic sheets have been shown to be cost-effective in protecting glacier mass, but there are limits to the area that can be covered by such sheets and they cannot prevent the eventual disappearance of glaciers if warming trends continue. Insurance, meanwhile, can reduce the financial losses from occasional instances of snow-deficient winters, but cannot protect against systemic long-term trends towards warmer winters.

Governments can also play a key role in facilitating sustainable adaptation in winter tourism

A key issue for governments is the degree of oversight that might be needed in what is, to a large extent, autonomous adaptation driven by market forces. One place where the government role might be critical is with regard to the environmental and social externalities that might be created by the implementation (or over-implementation) of particular adaptation strategies. For example, snow-making has implications on water and energy consumption, the grooming of ski slopes can reduce slope stability, while moving ski operations to higher altitudes can threaten fragile environments. Currently policies vary considerably, both across and within countries. France and Germany do not have regulations regarding snow-making, although some aspects are covered within existing regulations for water withdrawal. Austria, meanwhile, has explicit regulations, but they vary across provinces, while in Italy only South Tyrol has snow-making regulations. In Switzerland, meanwhile, snow cannons are subject to environmental impact assessment and there are specific regulations on where they can be used. Regulations vary similarly – or are absent entirely – for the use of snow additives, grooming of ski slopes, and moving ski activities to higher altitudes.

Yet another place where public policy might play a role is in facilitating transition for those at the "losing" end of the adaptation equation. This is because climate change impacts have significant equity implications. Smaller resorts, which also tend to be at low altitudes are both more vulnerable to climate change and have fewer resources for expensive adaptations. Meanwhile, ski conglomerates have lower climate risk (as their ski areas often have greater altitudinal range), better diversification of risk (as they operate a number of resorts), and more resources to make adaptation. Here again public policies vary considerably, from *laissez faire* (let the market decide) to the provision of financial support to those who are most vulnerable. In particular, a key tension that governments and local communities need to confront jointly is between adaptation measures that tend to protect the *status quo* for as long as possible despite increasingly unfavourable climatic conditions, and those which facilitate a smoother transition to the new realities of the changing climate. Overall, there has been more emphasis on preserving the *status quo*, and less on transitions that might be economically and politically expensive in the short-term.

Implications of climate change on natural hazards in the Alps are complex and hazard-specific

The second case examined in this report – natural hazards – is both linked to, and yet significantly different from, winter tourism. While climate change has clearly discernible impacts on winter tourism, its implications on a diverse array of natural hazards that are already prevalent in the Alps are much more complex. Furthermore, while adaptation in winter tourism has largely been autonomous and initiated primarily by the private sector, any responses to address the implications of climate change on natural hazards will almost certainly involve public agencies, require much more co-ordination and planning, and would be superimposed on existing policies and measures to deal with natural hazards. The necessity of suitable adaptation measures to the effects of climate change on natural hazards depends both on the strength of the linkages between climate change and particular hazards, as well as the overall significance of the hazard itself. This analysis concludes that many hazards which have strong linkages to climate

change actually have relatively low/medium economic significance. The clearest impacts of climate change on natural hazards occur in glacial and permafrost zones which may be of limited economic significance from a national perspective, although their implications for local communities may be quite significant. On the other hand, hazards which have considerably higher economic and social significance, such as floods and windstorms, have more complex and less certain linkages with climate change. Despite the uncertainty of climate change impacts on floods and winter storms, the risk related to these changes should be taken seriously given the impacts of such events and the growing vulnerability of Alpine societies to such events due to demographic, land-use and other pressures.

Climate change is one additional reason for effective management of current hazards

How best, then, to take climate change risks into account in dealing with natural hazards in the Alps? Clearly, a multi-pronged approach is needed. A natural place to start would be from the institutional structures and risk transfer mechanisms that already exist in the Alpine countries to deal with natural hazards. Climate change and its implications (even if uncertain) are one more reason to improve the efficiency of such structures and mechanisms. The three Alpine countries (France, Switzerland and Austria) examined in this part of the in-depth analysis clearly have very high adaptive capacities with regard to dealing with natural hazards. Institutional structures and regulations for managing natural hazards are in place, as are insurance mechanisms to facilitate risk transfer. While early hazard mitigation efforts focused primarily on disaster recovery, there has been growing emphasis on integrated natural hazards management that includes all elements of the risk cycle (from prevention to recovery). The Alpine Convention is also fostering the implementation of integrated management of hazards across the Alpine arc. Integrated hazard management offers several obvious entry-points for factoring in climate risk information, for example in hazard mapping, spatial planning, as well as the design of prevention measures. However this assessment also demonstrates that the Alpine countries nevertheless face significant challenges in dealing with current hazards, let alone the implications of climate change. For example, integrated management schemes are not yet fully operational, and in many cases implementation remains difficult. It is also noteworthy that, in all countries surveyed, there appears to be very little use of economic incentives to support and strengthen actual hazard prevention efforts. Insurance premiums, for example, are generally not linked to risk exposure, thereby reducing the incentives for undertaking risk prevention.

Climate change adaptation also requires more flexible and forward-looking natural hazards management

Natural hazards management traditionally relies on retrospective information which will no longer be appropriate if climate change alters hazard profiles and distribution. There is therefore a need for more forward-looking approaches that also consider anticipated climate risks. One strategy might be to raise the precautionary standard for hazards management, as including more intense and extreme events into the planning process will enhance resilience to climate change. For example, in Switzerland hazards maps have been adjusted to include events with a 300 year return period instead of being limited to 100 year events. Adjustments have also been made in the planning of emergency measures which now account for events with a 1 000 year return period. Another strategy would be to update hazard maps more frequently to enable decision-makers to take evolving hazard profiles into account, as is the case for permafrost and glacier hazards. Frequent updating of hazard maps, however, needs to be carefully balanced against the significant costs that this might entail. There might be also high transaction costs, and even legal challenges, if significant changes are made to hazard maps on a frequent basis, particularly if such changes are made purely on the basis of model-based projections. A mid-way solution, however, might be to use hazard maps that incorporate scenarios of future impacts as advisory, and not regulatory, tools.

Much like public decision-makers, insurance companies base their operational practices only on the basis of past hazard events. Going from a pricing methodology based on past evidence to the inclusion of theoretical considerations surrounded by large uncertainties may prove difficult to accept for consumers, and to implement by insurers, especially within a competitive insurance sector. However, awareness of climate change is growing among Alpine insurers. In Austria, private insurers are funding the development of local climate change scenarios while in France a consortium of insurers is examining the consequences of climate change on insurance reserves and pricing. These efforts are still in at an early stage and are yet to translate into changes in operational guidelines.

Active monitoring and risk reduction of climate change related hazards is also needed

Finally, in specific cases where climate related risks are rapidly evolving or the impacts are already evident, as is the case for permafrost and glacial risks, an effective adaptation strategy would be to institute risk monitoring and risk reduction projects. Some progress has been made on both these aspects. The European Union, for example, funded two regional activities: Permafrost and Climate in Europe (PACE) between 1997-2000 and Glaciorisk between 2000-2003, to monitor climate risks. At the project level, meanwhile, there are some examples of infrastructural adaptation measures to the increasing risk of permafrost and glacial hazards under climate change. These include the partial drainage of a potentially dangerous glacial lake on the Monte Rosa on the Swiss-Italian border, and the construction of protective dykes against avalanche and debris flows in Pontresina (Switzerland). While these developments are clearly encouraging, they remain, at best, isolated niche examples relative to the scale of the climatic changes underway in the Alps. There is also a clear need to establish more durable mechanisms for climate hazard monitoring that extend beyond short-term funding cycles, and to ensure that such activities extend beyond research and generate information and tools that can then be used to better incorporate climate risks in hazard maps and natural hazard management policies.