AUSTRALIAN INDUSTRIAL AND COMMERCIAL RESPONSE TO CLIMATE CHANGE: RISK ANALYSIS AND COMMUNICATION UNDER UNCERTAINTY*

L. M. DROSDOWSKY[1] and W. J. MAUNDER[2]
[1]*Special Services Unit***, *Australian Bureau of Meteorology, PO Box 1289K, Melbourne, Victoria, Australia*
[2]*President WMO Commission for Climatology and Consultant to Canadian Climate Centre, Canada*

Introduction

"The greatest challenge of the 1990's, then, is the establishment of the right incentives to encourage industry to minimise the negative effects of economic growth on the environment and to maximise the positive effects of such growth on society." Financial Review, 1 May 1991.

Any consideration of the impact of climatic change on Australian urban, industrial and manufacturing activities must recognise several facts. First, human-induced climate change has yet to be satisfactorily quantified. Second, any climate change will occur on local, regional, and global scales, and regional changes could be significantly different in magnitude and character from region to region. Third, any effects caused by 'climate change' will either accentuate or dampen any effects caused by local climate variations.

Depending upon the nature of their enterprise, some economic sectors will clearly view the effects of a climate change as adverse to their operation but, in other areas, sectors may actually welcome the changes. For example, very dry conditions may decrease wool production but increase wool quality; cooler conditions may decrease corn production but increase potato production. Similarly, drier and warmer conditions in, say, the U.S.A. may result in less productive crops whilst these same conditions in, say, Siberia may result in significantly more production. Further, an increase in the frequency of severe thunderstorms and tropical cyclones could provide an increase in opportunities in the building and construction indus-

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** The Special Services Unit (SSU) is the commercial arm of the Australian Bureau of Meteorology and was set up to respond to clients' specialised meteorological needs on a user pays basis. These clients come mainly from the commercial and industrial sectors and the SSU's role is concerned with raising these sectors' awareness of the importance to their operations of weather and climate information. These activities should also serve to raise, generally, public awareness of climate as a valuable resource.

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tries, more severe winters could increase the demand for heating, and more humid/hot summers could increase the demand for air conditioning.

It is also important to consider how much climate change can be experienced before it becomes significant in producing 'real' economic effects and in affecting decisions.

Regional (Country to Country) Considerations

One of the major problems when dealing with climate change is the fact that, except in exceptional circumstances, it is a gradual process, and one which may display changes in direction in the short term. It is, therefore, essential that it be viewed as on ongoing process requiring constant adjustment and re-evaluation.

Once the extent of expected regional change (particularly on a country to country basis) has been ascertained, individual countries must consider several other factors (Jodha and Maunder, 1990). First, how a climate change will affect not only their own country but also those of their competitors. Second, what sort of economy/society, in each country, can be realistically expected in, say, the years 2030, 2060 and 2090, and how should we react/adapt to any climatic change in the light of the kind of economy/society we would like to have. Finally, it is essential to appreciate that each country has a limited capacity, including sustainable resources, with which to attempt to appropriately tackle the problem of responding to climatic change.

The Importance of Weather

Weather changes always occur within a region's climate and, as such, are an accepted part of climate. Significant climate changes are usually caused by external forcing agents and are normally irreversible often with more far-reaching effects. For example, climate changes might be expected to increase the frequency and intensity of severe weather events in some areas.

It has been previously pointed out by many astute observers that society's *sensitivity* to the weather, i.e. to variations and extremes of rainfall and temperature, strong winds, fog and electrical storms, is increasing by virtue of such factors as the increasing population which leads to increasing pressure on existing resources such as food and water; and the increasing expectation of permanency of supplies in developing countries. Other important considerations (Houghton, 1990) include the increasing complexity of the infrastructure particularly in commerce and industry, the increasing efficiency in agriculture so that the percentage impact of weather on supply is higher in volume terms, and reducing margins in design and construction so that tolerances and allowances for extreme weather events are minimal. Another factors is the extent of vulnerability due to agricultural specialisation; one crop, or one strain, may be less able to withstand a climate change.

Industrial and Commercial Response

Before any objective decisions regarding response can be made by commerce or industry several further questions must be answered. How does the *current* climatic regime affect operations? How do organisations take into account climatic *extremes*? To what extent would the expected climatic *changes* affect operations and would these effects be positive or negative? If the effects are expected to have an adverse impact on operations, what would be the dollar costs of taking precautions (if indeed, actions can be taken) against these effects? Would these outweigh the benefits? Clearly, if the effects are expected to have a positive impact on operations, it would be extremely difficult to convince the organisations involved to assist in attempting to ameliorate these effects unless forced to do so by legislation or regulation.

For example, an increase in the occurrence of low pressure systems off the east coast of Australia in winter would result in a greater frequency of cold, windy weather. This, in turn, would significantly increase demand for heavier clothing. Further, since winter clothing is a higher return commodity than summer wear for retailers, the retail clothing industry would no doubt welcome such a change.

Another serious conflict that arises due to the gradual, long term nature of climate change is with respect to the time frame of most commercial and industrial decision making. The necessity of producing profits for shareholders and maintaining a competitive advantage over competitors requires, particularly in some sectors, decisions which focus almost exclusively, whether we like it or not, on the short term. These decisions, therefore, are quite likely to have a serious impact on organisations' perception of the importance of climate change to their operations.

Risk Analysis

If industrial and commercial sectors of the community or, for that matter any other sector, are to take any decisions regarding climatic change, some indication of the risk each is likely to be exposed to must be determined and communicated to these sectors.

With respect to climate change an organisation's risk may be at one or more levels. These include production risk, profitability risk, and risk associated with the public and shareholders' perception of the organisation's attitude to the problem. The importance of human perception cannot be over-emphasised as it affects the decision making process at both the individual and organisational levels. Equally importantly is the fact that the perception of risk at one level may not be consistent with that at another.

Given the fact that the exact nature of the climate change 'threat' is still to be quantified on a global scale, far less a regional one, consideration must also be given to several significant facts. Different groups react differently to the concept of risk i.e. some are more risk averse than others, different groups will interpret their

individual risk differently, and vested interests will doubtless be involved with the accompanying 'political' decisions being taken.

Indeed, any decision which has the potential to affect the current balance of power, money and the quality of life is guaranteed to result in conflict particularly, as is the case with the issue of climatic change, if there are underlying value judgements. For example, the relative mix of energy produced from fossil fuels, nuclear reactions and other sources, such as the sun and the sea, may change significantly during the next 20 to 40 years.

Possible Responses

It could be argued that all that business and urban planners need to do is to take out insurance against the possible adverse effects of any increase in, say, the frequency and intensity of severe weather events. However, if it is decided that, for example, severe thunderstorms accompanied by high winds are likely to significantly increase, this may result in construction standards being amended to include mandatory reinforcement of all structures. But what happens if no significant increase in the frequency and intensity of winds is experienced? Similarly, the problem could be one of not anticipating a significant change that *does* eventuate.

There are two possible alternatives for coping with this problem (Financial Review, 1 May 1991). Regulations (command and control) which requires direct intervention by governments to prevent certain actions and encourage others, and economic instruments which aim to change behaviour by the use of disincentives and incentives. Examples of the former include the setting of standards and the imposing of resource use quotas and, of the latter, tradeable pollution rights and deposit refund systems.

This leads to the question of whether or not it is valid to include a 'margin for error' to protect the public, and whether the appropriate responses are to be designed *by* individual groups or *for them* by external bodies. If the latter approach is to be taken, this also raises the additional problem of motivation of groups to react to an externally imposed perception of risk.

The underlying problem with implementing responses of this nature is that they represent *responses based upon uncertainty* and all such responses incur a cost. Therefore, it is important for all involved in meteorology, both the National Meteorological Services and those in the private sector, to recognise how vital it is to actively *market* meteorological and climatic information and *educate* the public (especially the commercial and industrial public) in the interpretation and use of such information.

Risk Communication

"Those most strongly motivated to communicate about risk are often also those with the strongest interest in the decisions. So whenever a personal or a social decision may affect interested groups, conflicting

messages that reflect the conflicting interests may be expected. The beliefs of risk communicators, and their interests, create incentives to slant or even distort or misrepresent information. This can skew messages in many different directions on the same issue". ('Improving Risk Communication', p. 115).

Once some quantitative measure of the risk involved with climate change is available, this risk must be communicated to those affected. The origins of problems associated with this communication process can be located in the message itself, the source of the message, the chosen channel(s) and/or the receiver(s) of the message ('Risk Communication', p. 111).

The problems associated with effective risk communication are numerous. The costs and benefits of risk are not equally distributed across a society, people do not agree about which harms are most worth avoiding or which benefits are most worth seeking. Citizens of a democracy expect to participate in debate about controversial political issues and about the institutional mechanisms to which they sometimes delegate decision making power. ('Improving Risk Communication', p. 20).

Handling Uncertainty

In situations involving uncertainty, there is always the possibility of error. Collingridge in Pidgeon (1988) suggests:

"The key ... is to choose those options which are highly corrigible, in the sense that they can be easily monitored, corrected cheaply, and allow time for correction; they should be easy to control, being responsive and well-behaved; and they should be flexible so that future options are kept open."

It would therefore, seem obvious that the first step in deciding upon appropriate strategies to be implemented is to reduce the amount of uncertainty in the decision making process. This requires an investment which, logically, should be spread over both the public and private sectors. However, in order to get support from members of these sectors, especially the latter, the benefits to be accrued from an investment in studies on the uncertainty associated with climate change must be demonstrated.

Profitability, Weather and Climate

The sensitivity of the aviation, shipping and agricultural sectors to the actual weather and the climate, as well as to information about the weather, has been recognised for some time but, more recently, other industrial and commercial sectors have begun to realise that their operations can benefit from appropriate weather and climate information. This realisation has been, in the main, prompted by two phenomena. The first is the growing political and social concern about the possibility of climatic change (usually thought to be adverse) being brought about by human induced activities. In addition, the current economic environment which is forcing business in nearly all countries of the world to actively seek new ways of making their operations more efficient and, hopefully, more profitable.

Despite this increasing awareness by industry that weather and climate are

important to their profitability, it is very difficult in any country, including Australia, to ascertain exactly *how important* in dollar terms the impact of a possible climatic change would be. This is particularly true with respect to a change in the frequency and intensity of severe weather events. It is equally essential that industry realise that any change *may* have an even greater economic and social impact in the future than it has had in past.

For the impact of possible climatic change to be quantifiable it is first necessary to evaluate the *current* and *past* importance of weather and climate information. To achieve this, the major companies would be required to either objectively assess this themselves or supply the information to an outside organisation for assessment. For an organisation to adopt the former course of action, it must be convinced that such an evaluation is worthy of an allocation of resources and this, usually, requires outside provocation.

The Importance of Real-Time Data

As pointed out (Maunder, 1989), weather information is one of the few forms of data (other examples being the foreign exchange rates, the stock market, electricity and gas consumption, and prices on the futures market) available on an hourly and daily basis. It can therefore be used in real-time to make predictions regarding economic and social impacts before the output from conventional economic techniques becomes accessible. This is because most, if not all, economic indices are only available on a monthly basis or, in very few cases, on a weekly basis. In addition, they are almost aways not available immediately after the end of the period in question, but are only available some time afterwards – at least a week, but in many cases, several weeks.

The economic and social impact of specific national weather or climate events is difficult to quantify particularly in Australia, due to a lack of case study material. However, using data from an 1981 study conducted by the Center for Environmental Assessment Services in the USA, after Maunder (1986), the direct costs of the 1980 heat wave and drought were estimated to have been as follows:

Entity	Loss in US $ million (1980 dollars)
Major crop losses	11,000
Livestock and poultry losses	1,000
Increase in federal and local government expenditure	1,000
Increase in power consumption; mainly additional air-conditioning	800
Increased requirements for health services	600
Losses in other sectors	3,000

This estimation was carried out based on weather data in near real-time; six months later official statistics were released confirming these weather-based loss estimates. Other evidence regarding the value of meteorological information to various sectors is somewhat scant; Maunder (1989) cites a mid-60's study which showed that weather losses in the building and construction industry were estimated to be 2% of the value of production in both the U.S.A. and the U.K. Furthermore, it was assessed that about 10% of these losses could have been avoided through the appropriate use of the weather forecasts available at that time. Similarly, the economic value of weather forecasts to construction in Sweden has been assessed at being 0.1 to 0.2% of total costs and this was about seven times the price paid for the forecasts.

Adjusting Economic Indicators for Weather Climate

It is essential to develop better evidence of the value of meteorological and climatological information to the Australian commercial and industrial sectors. The costs associated with this work need to be met by both the public and the private sectors. Methods must also be developed to accurately 'weather/climate adjust' national economic indicators.

An example of this is the suggested 'weather adjusting' of the *Business Week Index* of United States economic activity in order to take into account weather factors which increase or decrease electric power production in a 'non-productive' way (see Maunder, 1986, p. 295). The *Business Week Index* is (or, at least, was in the early 1980s) computed weekly by weighting 'seasonally adjusted' economic activities such as raw steel production, rail freight traffic and electric power production; the latter comprising 17.3% of the total activity weighting. The index, in the early 1980s, used a base year of 1967 = 100 and a comparison of the index for the summers of 1979 and 1980 shows average values of 150 and 138, respectively. This decrease of 12 points between 1979 and 1980 reflects the downturn in the U.S. economy that occurred at that time. However, according to Maunder (1986) the value would have decreased even more rapidly had not the summer of 1980 been extremely hot, which caused higher than usual power production due to record demand for cooling devices such as air conditioners. Therefore, the Business Week Index could be said to have been kept 'artificially' high as its computation assumed that any increase in electric power consumption was automatically associated with an increase in real, national economic activity. A further important consideration is that, since the severity of the heat wave was well known in real-time, and actually forecast several weeks in advance, it could be argued that these weather conditions could have been used to monitor, and more accurately predict, the U.S. economic activity at that time.

Conclusion

A significant amount of monitoring and research remains to be done in the area of climate change, both natural and human induced. Many of the goals will involve research and investigation peripheral to the normal activities of many meteorologists and climatologists.

Increased awareness, by industry and commerce, of the impacts and effects of climate and weather can lead to more cost effective operations. For this enhanced appreciation to be achieved, all groups involved in meteorology must actively market and educate the various sectors in the interpretation and use of meteorological and climatological information. For this end result, priority must be given to the development of new multi-disciplinary research involving fields such as geography, agriculture, forestry, economics, planning marketing, political science and sociology as well as meteorology and climatology.

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