Climate Change Research: Evaluation and Policy Implications
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Socio-economic and policy aspects of changes in incidence and intensity of extreme weather events. Preliminary results.

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Abstract

Climate change results in an alteration of spatial and temporal patterns of climate hazards. The trend in weather related disaster seems upward. Various socio-economic sectors are affected by these changes, e.g. the disaster reduction institutions and the insurance industry. We report about an ongoing project addressing the vulnerabilities of sectors affected and policy options in various sectors, notably "Storms over NW-Europe", "the insurance sector" (both as a sector impacted by change and as a mechanism to cope with risk) and "cyclones in the South Pacific".

1. Introduction

The upward trend in climate-disaster statistics has aroused interest in climate change issues in various sectors affected, among them the the insurance sector. The goal of the study is to contribute to the evaluation of this aspect of climate change, particularly the socio-economic aspects. The study was outlined at a workshop in which scientists from climatology, insurance and economics participated (Olsthoorn & Tol, 1993). The methodology is to construct scenarios of extreme weather events (storms, droughts etc.), their impacts and policy responses. Insurance is a focal point.

This paper reports about the ongoing work at IES-Vrije Universiteit, Amsterdam: the work done by the collaborating institutes (Environmental Change Unit, University of Oxford, Aristotelian University of Thessaloniki) will be published elsewhere. Sofar the IES-work, reported here, addressed the three topics briefly discussed below.

2. Storm over Northwest Europe: Daria modelled

In the winter of 94/95 Northwest Europe experienced an unusual period of seven severe storms. One of them, Daria, hit the Netherlands on the 25th and 26th of January 1990. This storm, the strongest since 1944 in the Netherlands, caused the death of 25 people and, at its height, brought traffic to a virtual standstill while the railway system was blocked completely due to many broken high-tension cables (Dorland et al, 1994). It caused widespread damage estimated at about Dfl 2.6 billion, of which Dfl 1.5 billion was covered by the insurance industry.

An extensive literature search was carried out to identify the policy responses to this disaster. It appeared that only in a few sectors (Dutch Railway, National Forestry) the events prompted reactions. Five years later hardly any societal traces are left. Apparently, a developed society is not vulnerable to such event (Albada-Bertrand, 1993); at a societal level an incidental damage of billions of guilders can be coped with (at its current incidence). However, studying the events will give clues about what will happen if climate change results in more intense and frequent storms. Unfortunately, much of the information gathered about the storm impact proved anecdotical and not suitable for modelling, except for damage data from the insurance industry. This industry provided information which allowed construction of a **storm-damage model** seeking to predict damages done by hypothetical storms. Such model is constructed by specifying a relation between spatially disaggregated (2-digit postal code area) data about stock-at-risk and corresponding windspeed data, and subsequent statistically estimating of the coefficients using the information about the actual damages done by storms. Sofar, only Daria could be modeled. The Centre of Insurance Statistics (CVS) provided data of storm-related claims (from privates, and not businesses and agricultural objects). Windfield data were obtained from the Dutch Met Office. Other variables included are the number of houses and the average income of households in the postal code areas. These variables together reflect the stock-at-risk in each area.

$$Damage = 1.8\,10^{-4} PH + 1.901 v^3 + 54250 AI - 11.9316$$

Damage = *Insured damage including deductibles* (*MDfl*)
PH = *Number of private houses*
AI = *Average income of households* (*thousand*)
v = *Maximal windgust* ($m.s^{-1}$)
$R^2 = 0.84$

The damage is put proportional to the third-power windspeed for physical reasons (force is proportional to windspeed to the third power). The model will be improved by incorporating other storms in the statistical analysis.

3. A weather insurance simulation model.

The recent large losses due to hurricanes, floods and storms not only aroused the attention of the climate change community but also of the (re)insurers. The larger part of the increased damage is, however, ascribed to the increase of socio-economic vulnerability and short-sighted price setting. Responses are now vividly discussed within the insurance sector. Three response types can be distinguished: the product can be adjusted by raising premia and restricting cover (increase of deductibles and rejecting low-probability high risks), the financial buffer-capacity can be enlarged (closer cooperation with banks and governments), and the vulnerability can be reduced (enforcement of building codes, land use zoning). The first type shifts the risk back to the insured, the latter types redefine the roles the various stake-holders play in risk management. The analyses suggest that the insurance sector is likely to be able to adjust to climate change without disproportional damage, provided that changes are not too fast or drastic and responses are clever.

In order to be able to quantitavely study the insurance sector in a changing climate, a a numerical dynamic model of the weather insurance market was constructed. This model, the *Weather Insurance Simulation Model* (*WISM.10*) (Tol et al, 1994), is used in a preliminary study the implications of hypothetical storm scenarios on the insurance sector. *WISM* is a model of the insurance market driven by a double stochastic process (Poisson-Pareto). The Poisson-Pareto process generates a random number of storms in a year and the corresponding random intensities (windspeeds) of these. One thousand sequences of a hunderd years are typically computed in order to calculate the means and variances of the model's output. Average frequencies and intensities are determined by factors constituting constant risk, gradual increases, slow cycles (representing the decadal climate variability), and cycles plus a trend. Again, storm damage is assumed to be the third power of storm intensity.

Storm inflicted damage is fed into a highly stylised, behavioural model of the main actors on the insurance market, viz., the insured, the insurers and the reinsurers. The actors' behaviour is based on their perception of the distribution of storm number, intensity and damage, which is in turn based on past observations. That is, the actors observe the random (!) figures of the previous years and base their expectations of the current year thereon. The (re)insurers are assumed to maximise their profits (premia minus expected losses minus risk factor), the insured to minimise their losses (premia plus expected losses minus expected claims plus risk factor). The (re)insurance market can assume several forms ranging from a regulated monopsony/monopoly to a free market. The average and standard deviation of main parameters, such as deductables, premia, (re)insurance cover, rentability and chance on insolvency, are calculated.

The first results indicate that the market form is largely irrelevant to the outcomes. In case storm frequency increases, the (re)insurers can and do shift the risk to the insured. The position of the (re)insurers is only mildly affected, whereas the insured face a substantial increase in expenditures. Long cycles in storm frequency have a similar impact. The picture is different when climate change changes storm intensity. The results indicate that increases in storm intensity affect all parties alike. Insurance cover and premia rise, but profits fall, and expenditures and insolvency chances rise. However, it is again the insured who suffer most. Moreover, important instruments to limit the reinsurers' risk have, sofar, been left out of the analysis.

In conclusion, the weather insurance model confirms the qualitative notions described above: The insurance sector is not likely to be a disproportionate loser under climate change.

3 Cyclones in the South-Pacific.

Apparently, wealthy countries such as the Netherlands can cope with severe storms; an obvious proposition is that developing countries (DCs) subject to tropical cyclones, more fierce than North-Atlantic cyclones, do not. The conditions necessary for tropical cyclone genesis prevail in the Tropical part of the Atlantic Ocean (except at the southern hemisphere), in the Indian Ocean and in the Pacific, by coincidence the area were most of the small island states are located. Tropical cyclones over Fiji is the subject of a case study adressing vulnerability of DCs to cyclones. Fiji (population about 750,000) is a small island state exhibiting typical characteristics of these kind of countries: a less diversied economy, tourism being a major sector. Agriculture, including a large subsistence sector, provides for most (80%) of the employment. Fiji is member of the Alliance Of Small Island States (AOSIS), which, as a representative of countries particularly impacted by climatic change, is involved in the international negotiations on climate change policy.

The statistics of cyclone incidence and and intensities in the South Pacific do not allow firm conclusions about trends (Tol et al, 1993); comprehensive statistics are available only since 1970. Since then 238 cyclones were recorded.

Since 1980, the islands of the Fiji archipelapo were struck by major cyclones in 1983, 1985 and in 1993. Seven, 27 and 23 people killed was reported. Damage was similar in the tree events: in the order of F$ 100 million. The government respectivily spent F$ 3.2 million (1985) and F$ 10 million (1990) on food relief in reaction of subsistence households losing crops. This amount is to compare with the government's capital expenditures which were in 1990 F$ 79 million. The Fijian tourism industry faced a 200%-300% increase of insurance premiums. Fiji started to develope pine forestry around 1980. In 1990 the export of timber accounted for 2.5% of the country's total export. However, cyclones appear to be the limiting factor for developing this sector; in 1990 10% of the stands had to be written off due to cyclone damage.

4 Conclusions

A comparison of the impacts of storms confirms the view that vulnerability is largely a function of development. Both in terms of casualties and damage done small, less developed, island states suffer much more in comparison. However, empirical data do not confirm the view that weather disasters hamper macro-economic development (Albala-Bertrand, 1993). The economic impact is distributional. In case of a changing storm regime insurance industry will suffer when it cannot adapt swiftly enough, while Fijian agriculture, forestry and tourism are likely to be restricted in development potential.

5 References

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