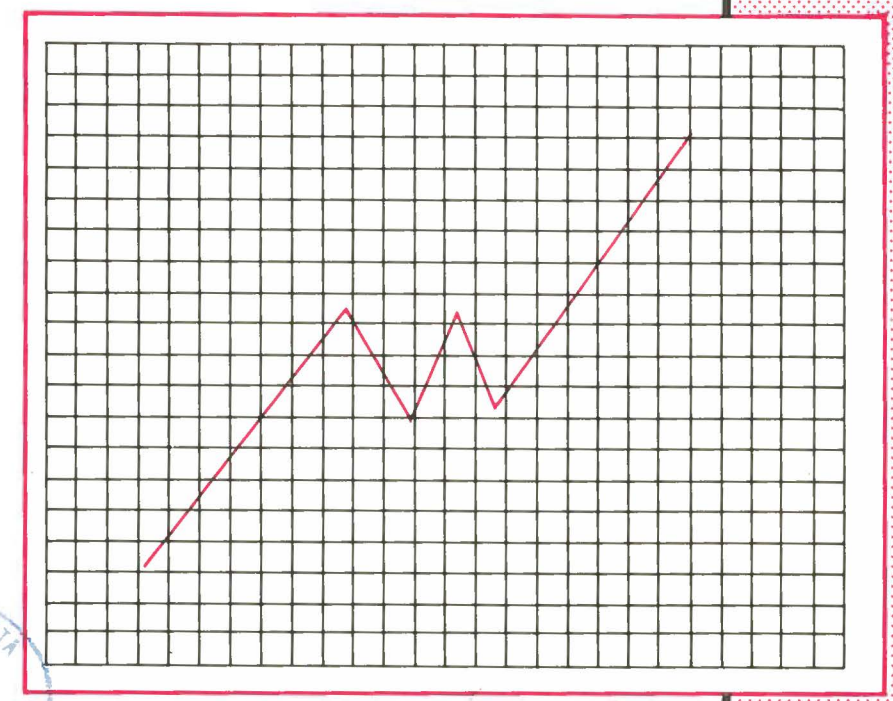

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FLOOD DAMAGE INSURANCE - A STUDY CONDUCTED ON THE LOWER UMFOLOZI PLAIN

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ABSTRACT

Flood damage on the Umfolozi Plain is statistically measurable, and flood damage insurance is therefore possible. Average annual net cash flow is greater and more stable with insurance than without it. Pool insurance has the greatest potential for use.

INTRODUCTION

For the purposes of this article, flood damage refers to direct tangible damage caused by a flood. Indirect and non-tangible damage is therefore excluded. The detrimental effects of flood damage, as indeed with any other risk factor in agriculture, operate largely via cash flow phenomena leading to potential problems in respect of solvency, liquidity and rentability of farming operations (Van Zyl and Groenewald, 1984a: 28).

In a previous study on the Lower Umfolozi Plain potential financial damage as a result of floods was quantified and probabilities were assigned to different levels (Van Zyl, 1983, Van Zyl and Groenewald, 1984b).

The risks attached to sugar production on the Umfolozi Plain, particularly with regard to the joint effects of flood damage propensity and farm size on cash flow, were demonstrated by Van Zyl and Groenewald (1984a: 28-32). By combining the flood level probability with the damage to flood peak ratio it is possible to determine the probability of a given level of flood damage being exceeded (Hydrological Research Unit, 1972). Using this method the average annual flood damage and standard deviation has been estimated at R108,33 and R300,94 per ha (1985 prices), respectively. Using another method proposed by Weiss (1976) 20 000 values of a probability (p) were generated as an evenly distributed series of random numbers. By linking damages to each of these probabilities an average annual flood damage of R113,15 per ha was obtained, while the standard deviation amounted to R361,13 per ha (1985 prices) (Van Zyl and Groenewald, 1984b).

The average outcome with regard to flood damage is therefore known, although individual outcomes would vary. Because what is being dealt with here is a risk, which is statistically measurable, it is possible to insure against flood damage provided expected damage is within actuarially acceptable limits (De Villiers, 1974: 6).

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Apart from insurance there is, however, a variety of other flood damage control measures that can be used with a view to reducing the risk and obtaining greater income stability. Flood damage control measures are taken to reduce the physical extent of the flood, to alleviate the effects of flooding on the individual and the community and to reduce the propensity to flood damage in different areas. These measures can be divided into predominantly structural and non-structural control measures (Spies *et al.*, 1977: 18-21).

By predominantly structural control measures is meant engineering works such as dams, canals and catchment area planning, aimed at altering the physical nature and extent of floods. Non-structural measures can be divided into two groups, namely Government instruments on the one hand and organisation and planning on the other. In the action taken by the authorities an attempt is made to gear human action to reducing the effects of a flood on individuals and on the community as a whole. Organisation and planning refers to action taken to prevent dangerous, uneconomic or undesirable utilisation of the flood plain in order to reduce damage (Water Resources Research, 1976: IV-2). Insurance falls under the non-structural measures.

Where previously, in countries such as the USA, the emphasis was on predominantly structural measures, it has with time shifted to include non-structural measures such as insurance. The main reason for this is that flood damage continued to increase over time in spite of the fact that large sums of money had been spent on structural measures. For this reason it is generally accepted today that flood damage control demands a composite strategy in order to be successful and that it should be approached within the wider context of flood plain planning (Water Resources Research, 1976: III-1).

The optimum combination of flood damage control measures for a given level of flood damage control benefits would be that at which these benefits could be provided at the minimum cost (Lind, 1967: 346).

INSURANCE

In the light of the reservations and concern expressed in Government circles (Van der Lingen, 1982) on the possible build up of a reserve by small farmers in order to manage when flood damage occurs, insurance should be afforded specific attention.

Compulsory flood insurance is proposed by Lind (1967: 347) as a way of preventing irresponsible

use of a flood plain. Whipple (1968), however, points out that state assistance with flood damage tends to encourage irresponsible and even dangerous uses of a flood plain. The danger exists, however, of a very high compulsory insurance premium resulting in entrepreneurs no longer being prepared to produce and in this way a scheme that would in fact have been profitable would come to nothing (Wiggens, 1974).

Insurance is protection against a definite specified loss. Pfeffer (1952) defines insurance as a method by which the risk attached to a damaging event can be lowered for one party (the insured party) by transferring such a specific risk to another party (the insurer). The insurer is in a position to offer the insured party full or partial protection against a possible economic loss by using a protection fund, built up over time with the contributions (premiums) of individually insured parties.

According to De Villiers (1974) insurance consists of four elements:

- it reduces uncertainty on the part of the insured party;
- it transfers the risk from the insured party to the insurer;
- the economic loss of the insured party is made good wholly or partially; and
- there are only two parties involved.

PREFERENCES

In the farming situation both security and opportunity are pursued, depending on the subjective judgement of the producer on the probable success of chancing a risk or the necessity for opting for protection and security (Friedman and Savage, 1962: 325). De Villiers (1974: 19-21) indicates this combination of security and opportunity by means of a utility curve including rising and falling marginal utility and income levels.

In the early stages of a farming venture, when available capital is limited, the producer's judgement is characterised by a pursuit of security, as shown in phase ab. Further avenues of profit are then pursued and this entails the taking of risks as shown in expansion phase bc. Friedman and Savage (1962: 327) reveal that the marginal value of additional income is so high at this stage that risks are taken which are not insured against. A consolidation period is then entered in which security is the major consideration, as shown in phase cd. In phases ab and cd the producer will therefore choose to insure.

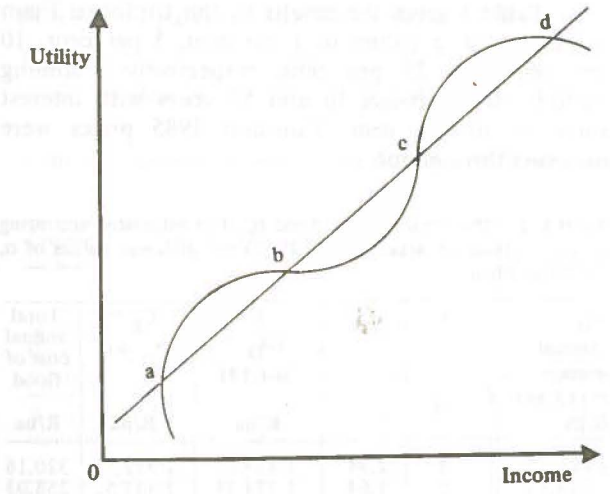

FIG. 1 - Utility curve

INSURABILITY OF RISKS

Only true risks of which the probability and the result are measurable are insurable. Furthermore, the insurance premium must be within the reach of the potential insured party and it must be regarded as economically warranted. The marginal benefits from insurance must therefore be at least equal to the marginal costs of the insurance (De Villiers, 1974).

Flood damage on the Umfolozi Plain has already been identified as a true risk (Van Zyl and Groenewald, 1984b). The probability of a flood of certain proportions is known, and the damage that such flood could be expected to cause has already been determined. Flood damage on the Umfolozi Plain is therefore an insurable risk. The question now is what form should such an insurance system take, since up to now there has not been one for flood damage on the Umfolozi Plain.

ALTERNATIVE INSURANCE POSSIBILITIES

In South Africa agricultural insurance has been undertaken primarily on a co-operative basis and it is mainly applicable to crops, namely insurance pools and guaranteed cover crop insurance (De Villiers, 1974: 36). Crop insurance usually takes one of three forms, namely hail insurance, insurance against fire and comprehensive crop insurance, primarily applicable to maize production. As far as could be established there is at present no insurance scheme specifically aimed at cover against flood damage. Possible reasons for this are, firstly, that production takes place on a limited scale only on the flood plains in the RSA. Another reason may be the lack of information in respect of flood records, and problems with regard to determining loss functions in different crops. Comprehensive crop insurance as far as maize is concerned, however, also covers flood damage, but maize production in areas subject to periodic floods is limited.

Insurance pools are not subject to the provisions of the Insurance Act, 1943 (Act 27 of 1943), which has been regularly amended since its commencement. Therefore it is possible to insure yields without guaranteeing a specific cover (Pretorius, 1968: 120). Claims are recovered on a *pro rata* basis according to the availability of funds. Pool insurance is potentially of the greatest benefit where a number of homogeneous producers can be grouped, a high degree of participation can be obtained, and a low risk situation arrived at by insuring against only one specific risk (De Villiers, 1974: 36-37).

Guaranteed cover crop insurance falls under the Insurance Act and any body that wishes to offer such insurance must register as an insurance institution in terms of this Act and is therefore obliged by law to comply with the requirements as set by the Act. Provisions of the Insurance Act require, among other things, a legal contract between the two parties, and that a reserve fund be set up in order to insure guaranteed cover by the insurer.

In this way only a financially strong undertaking with considerable available funds can offer guaranteed cover crop insurance of this kind. The number of producers on the Umfolozi Plain is limited and it is unlikely that existing companies will be interested in guaranteed cover insurance specifically against flood damage for this small group of farmers. Better then to examine the possibilities of an insurance pool.

As has already been mentioned the insurance pool is particularly suited to a homogeneous group of producers who wish to insure against one specific risk only. The implementation of such a pool system is therefore possible on the Umfolozi Plain where only sugar cane is cultivated and the producers wish to insure against flood damage only. One serious problem though is that the settlement farmers always suffer flood damage at the same time and for this reason the feasibility of a central stabilisation fund for this group of farmers should be looked at. The economic situation of sugar cane farmers on the Umfolozi Plain is described in Van Zyl and Groenewald (1984a).

INSURANCE PREMIUMS

Determining flood risks and then calculating premiums usually involves problems. An example here is the different levels of vulnerability and sensitivity of each flood plain user to a flood (Schaake and Fiering, 1967: 913-927; Kunreuther, 1970: 659-667; Krutilla, 1966). In order to determine insurance premiums scientifically comprehensive information is necessary and mathematical models, which must be revised regularly, are used (Whipple, 1968). It is probably on account of all these problems that insurance companies are not keen to underwrite flood damage insurance in South Africa.

If a limited number of producers participate in an insurance pool, their annual premium will under normal circumstances be equal to the expected average value of the annual flood damage (Lind, 1967). However, if there is a severe flood with a great deal of flood damage, the stabilisation fund could be inadequate for full compensation and in such a case damage would be compensated for only on a *pro rata* basis. The risk is therefore only partially insured against.

Grant and Ireson (1960: 265) suggest that in order to counter the effects of such catastrophic floods, a safety factor should be built in when the premiums are fixed. They propose that the expected value of the average annual flood damage should be increased by a reasonable percentage. According to Kuiper (1971: 235) this percentage should be 10 per cent. Schaake and Fiering (1967: 157) on the other hand suggest that it should be a fraction of the standard deviation.

The approach adopted by Maass *et al.* (1962: 150) is to consider the total costs attributable to flood damage within the planning period as the current value of the stream of expected values of the average annual flood damage plus the cost of uncertainty. He further recommends that a stabilisation fund be set up in the beginning of the planning period. If flood damage in any year exceeds the expected annual average amount the balance is recovered from the stabilisation fund. If the flood damage in any year is smaller than the expected annual average damage the balance is deposited in the stabilisation fund. Because it is impossible to make provision for every contingency, a certain probability or risk (α) is accepted that the stabilisation fund will run dry before the end of the planning period. Robinson (1970) in his analysis of flood damage recommends the approach of Maass *et al.* (1962).

The cost of uncertainty is the size of an additional fund needed to minimise uncertainty, namely:

$$U = V_\alpha \, \sigma_D / 2r \quad \ldots\ldots (1)$$

where U = cost of uncertainty

V_α = normal deviation with a probability α of exceedence

σ_D = standard deviation from annual flood damage around the expected value of the average annual flood damage

r = interest rate earned by stabilisation fund

The total cost of the flood $(C_F) = C_D + U \quad \ldots\ldots (2)$

where C_D = current value of the stream of expected values of average annual flood damage.

Comparisons 1 and 2 are valid irrespective of whether a stabilisation fund has been set up or not (Maass *et al.*, 1962: 151).

Table 1 gives the results of the Umfolozi Plain in respect of α values of 1 per cent, 5 per cent, 10 per cent and 25 per cent, respectively. Planning periods vary between 10 and 50 years with interest rates of 10 per cent. Constant 1985 prices were assumed throughout.

TABLE 1 - The total cost of flood (C_F) as calculated according to the method of Maass et al. (1962) for different values of α, Umfolozi Plain

C_D (annual average = 113,15) R/ha	α %	V_α	U (σ_D = 361,13) R/ha	$C_F = C_D + U$ R/ha	Total annual cost of flood R/ha
1 023,19	1	2,34	1 889,60	2 912,79	320,16
1 023,19	5	1,64	1 324,34	2 347,52	258,03
1 023,19	10	1,28	1 033,63	2 056,81	226,07
1 023,19	25	0,68	549,12	1 572,31	172,82

As can be seen the considerable variation in the cost of uncertainty is a result of the different levels of probability and risk attached to the exhaustion of the stabilisation fund before the end of the planning period. Although the results as set out in Table 1 provide no magic answer, they do provide a basis on which a rational evaluation of the results of a certain budgeting option may be based.

Simulation provides an alternative way of representing uncertainty in flood damage (Van Zyl and Groenewald, 1984b). Figure 2 draws a comparison between the simulation method and the results obtained using the technique of Maass *et al.* (1962).

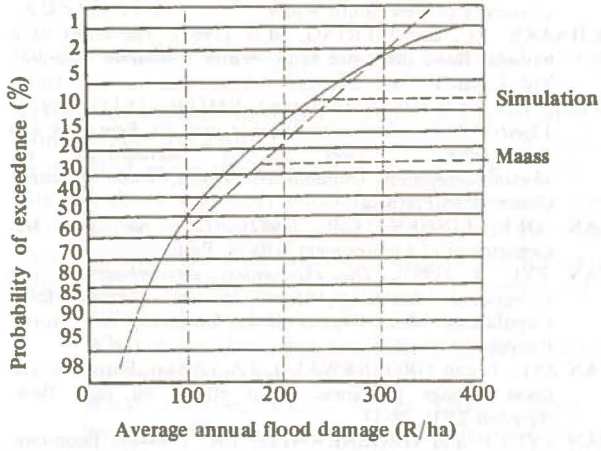

FIG.2 - Comparative frequency distributions of simulated flood damage and those according to the Maass et al. (1962) method, Umfolozi Plain (1985 prices)

The differences in results are primarily due to the fact that the method of Maass *et al.* (1962) is based on a hypothetical (normal) frequency distribution of annual flood damage, which is not influenced by the length of the planning period but which is dependent on interest rates. On the other hand, the simulation method is not necessarily based on a normal distribution and results are influenced by the length of the planning period.

BENEFITS FROM FLOOD INSURANCE

The benefits to be derived from flood insurance by sugar producers on the Umfolozi Plain can be calculated by comparing the average net cash flow for different sizes of farms with and without flood insurance (flood damage is the only source of variation). Table 2 gives the results of a comparison of this kind based on actual flood damage (at constant 1985 prices) for the period 1950 to 1985. The annual premium for flood insurance was set at R181,04. This is equal to the average annual flood damage for the period under examination.

From Table 2 it can be seen that the average annual net cash flow in respect of each farm size is higher where flood damage is insured against. This higher net cash flow is also entirely stable in the sense that it is not influenced by floods. Other sources of variation, for example prices, diseases and pests, were not taken into account in the calculations. There is a considerable variation in the net annual income stream where flood damage is not insured against. Flood insurance raises net cash flow in years in which flood damage occurs, while net cash flow in normal years is slightly lower.

In the calculation of the values in Table 2 the time value of money was not taken into account. It can, however, play a role. By taking on insurance one is paying an amount each year that only may be recovered in the future in the event of a flood. The money in an insurance pool or stabilisation fund of this nature is, however, invested at a certain interest rate. If this interest rate is equal to the average costs of capital of a farming operation, the premium will not be influenced. However, if a fund of this nature earns a higher interest rate than the average cost of capital then the premiums will drop and the benefits arising from insurance will be greater. If the average cost of capital is higher than the interest rate earned by the fund the benefits from insurance will be smaller.

The interest rate earned by the stabilisation fund or insurance pool can therefore play an important role. This means that the handling and control of such a fund may ultimately determine its success. An insurance pool or stabilisation fund such as this, can be handled by several bodies. Among them are existing insurance companies or co-operatives, the State and the Umfolozi Co-operative Sugar Planters Ltd.

Of these the Co-operative is perhaps the best equipped to provide a service of this nature, since all sugar cane producers in this area are members of the Co-operative. Moreover, the Co-operative is also

TABLE 2 - Average net cash flow for different sizes of farms, with and without flood insurance (1985 prices)

Item		Size of farm				
Insured or not	Net cash flow	50 ha	60 ha	70 ha	80 ha	90 ha
				R		
Without flood insurance	Average standard	12 041	16 123	19 036	20 837	21 756
	deviation	5 479	6 733	7 719	8 409	9 177
	Coefficient of variation	45,5	41,8	40,6	40,7	42,2
With flood insurance	Average standard	15 242	20 173	23 944	26 725	27 896
	deviation	0,0	0,0	0,0	0,0	0,0
	Coefficient of variation	0,0	0,0	0,0	0,0	0,0
Average benefits of insurance		3 201	4 050	4 908	5 888	6 140

familiar with the inherent problems associated with sugar cane production on the Umfolozi Plain and estimations of flood damage along with possible claims can be dealt with potentially more quickly and more accurately, to the greater satisfaction of the members of the insurance pool or stabilisation fund.

CONCLUSION

Because the average outcome with regard to flood damage for the Lower Umfolozi Plain is known and the risk is therefore statistically measurable, it is possible to insure against flood damage. Pool insurance has the greatest potential for application with a group of homogeneous producers, a high degree of participation and a low risk situation in that only one specific risk, namely flood damage, would be insured against.

The average annual net cash flow in respect of each farm size is not only higher where flood damage is insured against, but also more stable. As against this there is a considerable variation in the annual net income stream where flood damage is not insured against. Flood damage insurance raises net cash flow in years in which flood damage occurs, while net cash flow in normal years is slightly lower. Apparently then, flood damage insurance has, at least potentially, considerable benefits for the sugar cane producers on the Lower Umfolozi Plain.

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