Calculation of the secondary effects of floods in the lower Orange River area - A GIS approach

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Abstract

This article forms part of a series published in *Water SA* (commencing in Vol. 23 No. 3, July 1997 and Vol. 24 No. 3, July 1998) and builds on the information contained in the previous articles. Construing loss functions and flood damage simulation models as well as the assessment of the total direct flood damage have already been discussed in the mentioned articles. From the above-mentioned knowledge, it is possible to estimate the secondary effects of floods with different probabilities of occurrence. For this purpose damage is considered and assessed from a regional and national point of view. In the economy of a country there are forward and backward linkages between different sectors. This implies that the real impact of floods has wider implications than the merely direct and this is one of the reasons why the secondary effects of floods are assessed.

The flood plain of the Orange River, downstream from the Gifkloof Weir up to the Manie Conradie Bridge at Kanoneiland was used as study area for the research.

The aim of the article is to determine the secondary effects of floods from a regional and national point of view. First of all a methodological review is provided, after which the secondary effects of floods for the studied area are indicated.

Introduction

Once the total direct flood damage has been determined (Du Plessis and Viljoen, 1998), it is possible to calculate the secondary effects of floods from a regional and national point of view. The total direct impact of floods is discussed and assessed from the point of view of the farmer. As a result of forward and backward linkages between different sectors, the real impact of floods has wider implications than in a mere direct sense and this is one of the reasons why secondary effects of floods are estimated.

The items that are regarded as flood damage and the extent of the damage will differ depending on the point of view from which it is approached. Thus, for example, a loss in turnover for the agricultural community may be regarded as a loss for the individual who suffers it, while from the point of view of the local community it does not imply any damage if it is cancelled by increased turnover by a different enterprise in the local community. Should the loss in turnover by an enterprise be cancelled outside the local community or region, it is not regarded as damage from a national point of view, but is still seen as such in a local or regional context.

The aim of this article is to determine the secondary effects of floods from a regional and national point of view. The input-output technique is used for this purpose. First of all a brief methodological review of the secondary effects of floods as seen from a regional and national point of view is given, after which the extent of the secondary effects of floods with different probabilities of occurrence is calculated.

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Methodological review

The input-output technique is used for estimating the secondary effects of floods; information which is important to public authorities. Information concerning the secondary effects of projects has little value for private enterprises, while in the case of public projects it is of great importance for the evaluation of economic profitability. It is important to measure the extent as well as the concentration of the ripple effects of projects. Bell, Hazell and Slade, as quoted by Kirsten (1989) stated that the ripple effects of an agricultural project are considerable and especially centred in the local economy. Miller and Blair, as quoted by Botha (1991), regarded the input-output technique as an excellent and powerful technique especially for providing answers to certain policy questions.

The input-output model is a mathematical representation of an economic system that provides a review of the transactions (sales and purchases) between the different sectors or industries within an economic system. Miller and Blair (1985) discussed demand, supply and price input-output models with the demand model dealing with the backward linkage effects, the supply model with the forward linkage effects and the price model with the influence of a change in prices. The demand model is used most often and is also regarded as the standard model. Van Seventer (1990), quoted by Botha (1991), warned against the simultaneous use of both the demand and supply models as this can result in double counting.

Assumptions and limitations of the input-output table

The input-output table is based on three basic suppositions, namely homogeneity, linearity and proportionality and Botha (1991) summarised these as follows:

- The homogeneity assumption proceeds from the assumption that all the industries in a specific sector are homogenrous in

terms of products and cost structure. This assumption is necessitated by the fact that the input-output model is based on the general equilibrium theory.
- The assumption of linearity presupposes linear and homogeneous production relations and no provision is made for scale benefits. This assumption creates conceptual and technical problems and can lead to inaccuracy of empirical results.
- According to the supposition of proportionality the quantity of inputs used by a specific sector is directly related to its production level. Inputs are therefore used in fixed proportions to production.

Kumar (as quoted by Kirsten, 1989) listed an additional five assumptions of the model:

- Prices and wages are constant.
- There are no supply restrictions.
- All transactions are valued at producer prices.
- Inputs are recorded at the stage at which they are used in the production process.
- Externalities are not taken into account.

If the input-output model is used as a forecasting model, there are additional shortcomings over and above the mentioned limitations. Botha (1991 - translated) mentioned the fact that second- and third-round linkage effects are not felt immediately. A period of time is required for this, on the assumption that the economy functions at full employment or, put differently, the analysis does not accept any re-employment of factors (land, capital, labour) that are freed by a change in the level of economic activities.

Secondary effects of floods from a regional point of view

Normally full employment is one of the main objectives of macro-economic policy. Practically it is impossible to achieve an employment level of 100%, as there will always be a percentage of the unemployed potential workers as a result of labour transfers, people looking for a new job or structural changes in the economy. Against the background of macro-economic theories, a methodology for the calculation of the secondary effects of floods from a regional point of view can be developed.

If the economy does not function at full employment, floods *inter alia* create job opportunities. Contractors and workers who were not part of the labour market, now find work as a result of the flood (to restore flood damage), which would not have been the case otherwise. This has a stimulating effect on the economy as the opportunity cost of labour is lower in this case than it would have been if the economy had been functioning at full employment. If the economy does function at full employment, the opportunity cost of labour will be high. The withdrawal of workers from the labour market will then result in the economy suffering a loss as a result of sacrifices that have to be made in order to restore the flood damage. In this case the stimulating effect on the economy is ignored.

An analysis of the South African economy (Du Plessis, 1994) showed that at that point in time it is not functioning at full employment and that full employment will also not be achieved in the foreseeable future. The secondary effect of floods therefore has a stimulating influence on the economy and provision has been made for this in calculating these secondary effects.

Regional output multipliers

The input-output table can be used as an analytical instrument for measuring the effects of an autonomous disturbance in the economy. The calculation of the direct input coefficient matrix as well as the Leontief inverse matrix (matrix of interdependence) can be used as instruments for economic analysis (Botha, 1991). With the latter two matrices available, different types of multipliers can be deduced, although only output multipliers have been used in this study. In addition the closed inverse matrix has been used in this study as it also takes the effects of expenditure by households into account.

Output multipliers indicate the total values of a sector's requirements in order to be able to provide a final demand of R1.00 for its product (Botha, 1991). The size of the output multiplier determines the interdependence between the specific sector and the rest of the economy. In this study a regional input-output table compiled by the Department of Land and Development Affairs was used to calculate the direct input coefficient table. After the input coefficient table had been compiled, the Leontief inverse matrix was calculated by means of mathematical manipulation. Table 1 provides a summary of the output multipliers and Du Plessis et al. (1995) can be consulted for a more detailed analysis. The smaller this multiplier, the more insignificant are the linkage effects between this specific sector and other sectors in the region.

In this study only agricultural and commercial multipliers were used and these are indicated as 1.016893 and 1.006453 respectively in Table 1. Multipliers were verified in consultation with Nel (1995) The main reason for the "small values" is that the input-output table for a specific region was used, with transactions between regions regarded as final goods. Had the transactions between regions not been regarded as final goods and services, but as intermediary goods and services, the multipliers would have been larger. An additional reason for the small values is that relatively few transactions took place between the different sectors in Region B. The multipliers are used to calculate the secondary effects of floods on Region B. The input-output table for Region B is divided into nine sectors and does not distinguish

TABLE 1
LEONTIEF INVERSE MATRIX, DEVELOPMENT REGION B* 1985

Sector	Output multiplier
Agriculture	1.016893
Mining	1.004202
Manufacturing	1.061111
Electricity	1.001719
Construction	1.012069
Commerce	1.006453
Transport	1.003383
Financing	1.002809
Services	1.011317

Source: Du Plessis LA (1994)
* Development Region B includes the Western Cape at Upington under the old political dispensation of nine regions.

between different agricultural products, with the result that a common agricultural multiplier was calculated, not one for each agricultural product separately.

Secondary effects of floods from a regional point of view

Once the agricultural and commercial multipliers mentioned above are known, it is possible to estimate the total impact of floods. First the total direct damage to harvests is multiplied by the agricultural multiplier. As a result of the low opportunity cost of labour, damage to crops and the soil has a stimulating effect on the region because additional labour is required to re-establish vineyards. Soil damaged during the flood is restored by the farmer himself or by contractors. Consequently more fuel is used and more work done. For this reason the total direct damage to crops and soil is multiplied by the commercial multiplier in order to determine the secondary effects of floods. The secondary stimulating effect on the economy can then be calculated by subtracting the total direct damage to crops and soil from the total direct plus secondary damage. The secondary effects on building structures are calculated in a similar manner by multiplying the total direct damage to building structures by the commercial multiplier for the region. In this case too a stimulating effect is present which is added to the stimulating effect of damage to crops and soil in order to calculate the total stimulating effect on the region.

By subtracting the indirect stimulating effect on the economy from the total direct and secondary damage, the total negative impact of floods (direct and secondary) from a regional point of view can be determined. This calculation is done for floods with different levels of probability of occurrence in order to calculate the total mean annual direct and secondary flood damage for Region B.

Secondary effects of floods from a national point of view

In contrast to the input-output table for Region B in which multipliers are only available for the various sectors, the national input-output tables were compiled in such a way that it was possible to calculate the multipliers for every agricultural product in the RSA. To date the assumption was that market prices reflect the community value of inputs and outputs. In this regard Hansen, 1978 (as quoted by Bradfield, 1987) maintained that in a perfect world shadow prices of inputs and outputs would be equal to their market prices. Sugden and Williams, 1978 (quoted by Bradfield, 1987) pointed out that only the market price is required for financial analyses, but in the case of a cost-benefit analysis the welfare of other interest groups must also be taken into account. In actual fact the prices of inputs and outputs are often not determined by demand and supply, because of the existence of monopolies, intervention in the working of the price mechanism and the introduction of tariffs and/or quotas. In order to solve the problem, market prices are adapted to shadow prices. Gittinger (1982) defined a shadow price as the value which is used in economic analyses of a project as a cost or benefit when the market price is a poor representation of the true economic value. From this it is clear that there are project results that are not taken into account in market prices. The result of the shortcomings is, for the purpose of comprehensive cost-benefit analysis, that community benefits and costs of projects are not being reflected in the market prices of products and services. Todaro (1985) discussed five reasons why market prices do not reflect the real benefits and costs and can be consulted if necessary.

In the empirical part of this study market prices were adapted in co-operation with Bradfield (1994) and served as input in the flood damage simulation model. The approach must be regarded as a first-round approach and more complete procedures should be applied to determine the total social impact of floods.

Calculation of shadow prices in the study area

During conversations with Bradfield (1994) it was decided to adapt prices as contained in the various crop enterprise budgets where necessary. Bradfield (1994) determined the extent to which prices of items contained in the crop enterprise budgets were under- or overvalued. In general the prices of inputs such as fertilisers and pesticides were overvalued and had to be lowered by an average of 13.7 and 14.9%. In comparison with the world price of maize, the maize price was overvalued by approximately 18%, and the gross income from maize was lowered by 18%. Few adjustments to the income portion of the other crop enterprises were necessary, because most vineyard products (drying and wine grapes processed by the South African Dried Fruit Co-operation and Orange River Wine Cellars) could not be compared with a world price. Once the different adjustment rates had been established it was possible to adjust the various items in the crop enterprise budgets. The adjusted gross income, direct allocated cost, harvesting cost and re-establishment cost were used for the calculation of the secondary effects of flood damage from a national point of view.

National output multipliers

In addition to shadow prices, national output multipliers were calculated for every agricultural crop in the study area. The input-output table for the national economy was compiled by the Department of Regional and Land Affairs (1992). Ninety-three sectors were represented in the input-output table, agriculture being one of these. The nine development regions (Regions A to J) were subdivided into 78 statistical regions and 43 agricultural products were distinguished in the case of each statistical region. The multipliers for each statistical region were calculated in the same way as regional multipliers. Upington fell in Development Region B in the Gordonia/Kenhardt magisterial district. According to the Department of Regional and Land Affairs (1992), this magisterial district was located in Statistical Region 17. Multipliers were calculated for all 43 agricultural products and Table 2 provides a summary of multipliers of agricultural products in the region.

Because loss functions do not distinguish between different rotational crops, the multipliers for maize, cotton and peanuts were subjected to further processing. A weighted value according to area planted was calculated, namely 1.9449, and was used as a national rotational cropping multiplier.

Secondary effects

A method for determining which part of sultana yield must be multiplied with the dried fruit and wine-growing multipliers respectively in order to determine the secondary effects of floods, was developed largely on the basis of own research. For the assessment of the secondary effects on crop damage in the case of sultanas, two cases were studied. The first case comprises the procedure to be followed if farmers have not harvested at all, while the second procedure is used in cases where farmers do succeed in harvesting a part of the crop before the flood event. The price ratio between the income derived from wine-making and drying in the case of sultanas determines which part of the

TABLE 2
NATIONAL AGRICULTURAL MULTIPLIERS FOR STATISTICAL REGION 17 APPLICABLE TO THE AREA BETWEEN THE GIFKLOOF WEIR AND THE MANIE CONRADIE BRIDGE AT KANONEILAND, 1988

Product	Production multiplier
Dried fruit	1.2876
Wine-growing	2.2333
Lucerne	2.1758
Maize	1.8038
Cotton	2.1748
Peanuts	1.5225
Rotational cropping (weighed value)	1.9449

Source: Input-output table for agriculture according to subregions. Department of Regional and Land Affairs, September 1992

harvest must be multiplied by the multipliers for wine-growing and dried fruit respectively. The calculation of the secondary effects of floods if the farmer has not yet harvested any part of the crop, is taken as the price ratio of the wine-growing income derived from sultanas multiplied by the difference between the incomes with and without a flood. The result of this calculation is then multiplied by the multiplier for wine-growing. This is added to the price ratio of the income derived from drying sultanas multiplied by the difference between incomes with and without a flood multiplied by the multiplier for dried fruit.

If a farmer has harvested a part of the crop, the procedure for the calculation of the indirect impact differs in this regard that the remaining unharvested part of the crop is also multiplied by the multiplier for wine-growing (based on the assumption that farmers only make wine from sultanas after the crop has been damaged by flood water). As a result of the flood more wine is made and therefore it has a stimulating effect on the wine industry. For the calculation of the secondary effects in the case of other crops, the total direct damage to harvests is multiplied by the multiplier applicable (Table 2) in the case of each separate crop.

A stimulating effect is also present in the case of crop damage in that new vineyards have to be established. The additional purchasing of plant material and other materials required for establishing vineyards has a stimulating effect on the economy (on the assumption of less than full employment), which would not have been experienced otherwise. The total cost of re-establishment is used to determine the total impact of floods on crop damage.

As far as the secondary effects pertaining to soil damage are concerned, the total direct soil damage is multiplied by the national commercial multiplier. In this case the economy is also stimulated (on the assumption that the economy does not function at full employment).

From a national point of view the total (direct and indirect) damage is estimated by adding total net damage to harvests, total direct damage to crops, total direct damage to the soil and total cost of re-establishment. From a national point of view the total net damage is calculated by subtracting the stimulating effect on the economy from the total damage as calculated from a national point of view.

Empirical results

From the discussion above, it is possible to estimate the secondary effects of floods from a regional and a national point of view.

Secondary effects of floods from a regional point of view

The damage, resulting from a flood with the greatest probability of occurring at any point in time during a given year, is estimated from a regional point of view. In contrast to the direct damage, the net damage from a regional point of view is only estimated for a 5 March flood and the effect of other floods (that may occur at other times during the year) is not discussed. The effect of levees on flood damage is calculated for an average levee height of 1.6m (Ekkard, 1993).

Against the background sketched above, the total impact of floods with different probabilities of occurrence was calculated for Development Region B with the aid of a flood damage simulation model. Table 3 is a summary of flood damage resulting from a flood that may occur on 5 March from a regional point of view.

From a regional point of view the mean annual flood damage for the study area without building structures and without taking the effect of levees into account is estimated at R12.734 m. in total and R2 899/ha. Damage to building structures is relatively low and the damage including building structures is only 3% more than in the case of flood damage without building structures. The total net damage amounts to R9.085 m. and R2 068/ha if the benefits of levees (building structures included) are taken into account. If this damage is compared with the total net direct damage, the secondary effects of floods on the region are approximately 22.6% more than the direct damage in the study area.

As in the case of direct damage, the secondary effects of floods for Region B can also be converted to the universum. In this case the mean annual damage (MAD) for Region B amounts to R55.714 m. A shortcoming of this method of extrapolation is that it accepts that the same type of land-use pattern also occurs elsewhere in the area. In addition the effect of levees that was only taken into account for a relatively small area is carried over to the universum. As a result of river characteristics unique to an area, the hydrology can be expected to differ, especially over a large area, with the result that damage will vary from one place to another. Damage was therefore merely extrapolated and does not necessarily reflect the real damage. It is always better to divide a large area into sub-areas and estimate damage for each sub-area, rather than to simply extrapolate from one small area to the universum.

Secondary effects of floods on other sectors in Development Region B

The secondary effects, in other words the linkage effects with other sectors of the agricultural sector which suffer direct flood damage, are discussed in this paragraph. By making use of the various coefficients in Table 1, it is possible to determine the secondary effects of floods on other sectors. To restore the damage caused by the flood to a pre-flood level, it is necessary to

TABLE 3 NET TOTAL MEAN ANNUAL DIRECT AND SECONDARY FLOOD DAMAGE (MAD) FOR REGION B BETWEEN THE GIFKLOOF WEIR AND THE MANIE CONRADIE BRIDGE CALCULATED AT 1992 PRICES			
Flood	**Total damage without buildings and levees* (R)**	**Total damage with buildings but without levees (R)**	**Total damage with buildings and levees (R)**
Five year**	37 220 615	37 842 931	20 476 349
Ten year	53 293 585	54 492 239	34 716 749
Twenty year	71 792 003	73 776 314	53 220 377
Fifty year	83 967 276	87 300 357	73 240 263
Regional maximum flood	96 806 952	107 086 519	97 373 715
MAD	12 733 916	13 139 458	9 085 109
MAD/ha	2 899	2 991	2 068

* Damage to building structures includes damage to structures and contents of buildings. "With" and "without" temporary levees refer to the effect of temporary dams on the MAD.

** A flood with a return period of 1 in 5 years has a 20% probability of occurrence in any year.

TABLE 4 SECONDARY EFFECTS OF FLOODS ON INDIVIDUAL SECTORS IN REGION B BETWEEN THE GIFKLOOF WEIR AND THE MANIE CONRADIE BRIDGE, CALCULATED AT 1992 PRICES	
Sector	**Secondary effects of floods on individual sectors (R)***
Agriculture	9 139 758
Mining	6 446
Manufacturing	62 972
Electricity	1 310
Construction	402
Commerce	14 115
Transport	10 911
Finance	1 119
Services	1 551

* Rand values represent the net total mean annual secondary effects of floods. The secondary effects of floods on the different sectors do not add up to R9.085 m. This is due, on the one hand, to the fact that the coefficients in Table 1 are rounded off, and on the other hand to certain shortcomings in the input-output tables which have already being discussed.

spend approximately R7.029 m. in the agricultural sector, which represents the total net mean annual direct damage experienced by producers in the study area. As a whole the region (between the Gifkloof Weir and the Manie Conradie Bridge) however suffers damage to an amount of R9.085 m./a. The secondary effects of floods on the other sectors are summarised in Table 4.

The secondary effects of floods on the different sectors are relatively small (Table 4). There is little linkage among the sectors which is indicative of little interdependence with the rest of the economy. The latter fact is reflected in the small multipliers. The greatest forward linkage is encountered within the agricultural sector and represents 98.93% of the total secondary effects. This confirms the statement by Bell, Hazell and Slade, quoted by Kirsten (1989), that the ripple effects of an agricultural project are considerable and especially centre around the local economy. Floods have the least effect on construction (0.0043%), and the largest on manufacturing. The produce of vineyards in the area studied is processed to raisins and wine by the South African Dried Fruit Co-operation and the Orange River Wine Cellar respectively and this explains the greater effect on manufacturing. Floods in the region result in manufacturing suffering a mean damage of R62 972/a. Commerce provides important inputs in respect of agriculture such as, for example, seed, fertiliser, vines, poles and fencing materials in order to make agricultural production in the region possible. Floods result in agriculture buying less from the commercial sector with the result that commerce suffers a mean flood damage of R14 114/a. In similar fashion the forward and backward linkage between agriculture and other sectors can be pointed out.

The extent of the stimulating effect of floods on the region is so small and is overshadowed by the negative effect. The total stimulation resulting from a 5 March flood, taking the effect of levees into account, plus damage to building structures as seen from a regional point of view, amounts to R297 782. From a regional point of view the total average stimulation per annum resulting from the same flood only amounts to R31 074, as

TABLE 5
NET TOTAL MEAN ANNUAL FLOOD DAMAGE BETWEEN THE GIFKLOOF WEIR AND THE MANIE CONRADIE BRIDGE AS SEEN FROM A NATIONAL POINT OF VIEW, CALCULATED AT 1992 PRICES

Flood	Net total damage with building structures and levees without shadow price adjustment (R)	Net total damage with building structures and levees with shadow price adjustment (R)
Five year *	20 788 099	36 478 771
Ten year	36 552 945	55 152 627
Twenty year	56 826 230	74 405 783
Fifty year	105 224 923	113 484 740
MAD	9 606 887	13 265 277
MAD/ha	2 187	3 019

* A flood with a return period of 1 in 5 years has a 20% probability of occurrence in any year.

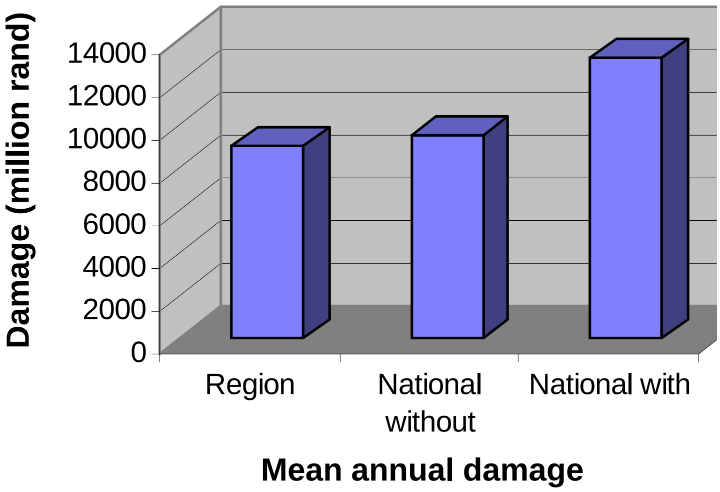

Figure 1
Mean annual damage from a regional and national perspective, calculated at 1992 prices
Explanation:
National without: Without shadow prices
National with: With shadow prices

compared to the total average annual damage of R9.085 m.

The floods that occurred in 1974 and 1988 have a return period of 1:20 years. If the total net damage resulting from a flood with a 5% probability of occurrence is multiplied by the coefficients in Table 1 in order to indicate the losses to the different sectors as a result of the specific flood, manufacturing suffers a loss of R305 539.

Secondary effects of floods from a national point of view

The procedure that is followed to estimate the total impact of floods from a national point of view, differs from the procedure that is used to do the same from a regional point of view, on the one hand because a multiplier is available for every agricultural product and, on the other hand, because sultanas can be used for both wine-making and drying purposes. This results in the calculation of the secondary effects in the case of sultana being of a more extensive nature than in the case of other crops. As in the case of the secondary effects of floods as seen from a regional point of view, damage as seen from a national point of view is also only calculated for a 5 March flood. The effect of levees and damage to building structures is also taken into account. Calculations are done with and without shadow price adjustments. The results are summarised in Table 5 and discussed briefly.

With an average levee height of 1.6 m the net mean annual flood damage as seen from a national point of view without the effect of shadow prices amounts to R9.607 m. If market prices are adjusted to reflect the real economic value of commodities, the total mean annual flood damage amounts to R13.265 m. The adjustment of market prices to shadow prices has a great effect (27.58%) on flood damage from a national point of view. In addition the effect of shadow prices increases the secondary effects of floods. This example indicates that the effort to make shadow price adjustments, is justified.

From a national point of view the secondary effects of floods (mean annual damage) are 31.51% more than the secondary effects from a regional point of view. Even without the effect of shadow prices, flood damage is higher (5.43%) from a national point of view than from a regional perspective. Figure 1 is a graphic representation of the difference in damage from a regional and national point of view.

The type of land-use pattern that is encountered in an area that is studied, should have a considerable influence on the extent of shadow price adjustments. Should other crops be cultivated, it might require more price adjustments, which could possibly lead to a higher or lower mean annual damage from a national point of view. Nevertheless it appears that the impact of shadow prices is significant and, where applicable, market prices should be adjusted so that the real economic value of products can be reflected by the shadow prices.

Summary

In this article the ways in which the secondary effects of floods can be estimated from a regional and a national point of view were discussed. The input-output technique was used for both estimates. The methodology used was largely developed on the basis of own research. The methods used for estimating the secondary effects of floods from a regional and a national point of view differ and were discussed separately. In addition to the output multipliers that are required for estimating the secondary effects of floods from a national point of view, the market prices were adjusted to shadow prices in order to reflect the true economic value of different commodities and inputs.

The net total mean annual direct and secondary flood damage for Development Region B between Gifkloof Weir and the Manie Conradie Bridge for 5 March floods amounts to R9.085 m. and R2 068/ha. Ripple effects of agricultural projects are considerable and especially centre around the local economy. Floods in this region have the greatest secondary effect (98.93 %) on the agricultural sector. During floods agriculture can deliver less produce to other sectors which are responsible for the further processing and marketing thereof. The vast quantity of vineyard products from Region B processed by the South African Dried Fruit Co-operation and the Orange River Wine Cellar in Upington results in an important forward linkage effect between agriculture and manufacturing. Manufacturing's share in the total loss caused by flood damage in the agricultural sector amounts to 0.68%. There is a backward linkage between agriculture and commerce in that commerce provides important inputs to agriculture, such as seed, fertilizer and vines. If the economy does not function at full employment, floods also have a stimulating effect on the local economy. The stimulating effect of floods on the region is insignificant and is canceled by the extent of the total mean annual flood damage. The total mean annual stimulating effect of floods on Development Region B amounts to R31 074 at 1992 prices. Agriculture buys fewer inputs from commerce and commerce therefore suffers a mean annual loss of R14 115 at 1992 prices.

Form a national point of view the secondary effects of the 5 March floods amount to R13.265 m. at shadow prices compared to R9.6 m. at market prices. The difference between flood damage at shadow prices and at market prices is significant (28%) and the adjustment from market to shadow prices for the purpose of estimating flood damage from a national point of view is justified.

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