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THE INTRODUCTION OF LABOUR INTO THE SCENARIO GENERATING SYSTEM

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contents

1. Introduction

In the research project optimisation of regional water management a two-step procedure is formulated. In the first step (the Scenario Generating System) a scenario is generated which has the following characteristics:

- the development (in time) with respect to environment and public water supply corresponds with the conditions formulated by the policy maker;
- the development of agriculture is such that income is maximized within the boundaries stemming from the hydrological system and by the conditions with respect to environment and public water supply. The development of employment in agriculture is within the boundaries posed by the policy maker.

In the second step (the Policy Analysis System) the impacts of possible policy alternatives are analysed. This analysis will be based on behavioural models.

The Scenario Generating System (SGS) consists of a linear optimisation model (the first level model) and a number of complicated (possibly nonlinear) models (the second level models). The first level model describes the hydrological system, the development of the users of the water (agriculture, environment and public water supply) and the interactions between these users. This description is rather simple. The second level models give a more detailed description of specific elements in the system. These models are used to support the first level model by calculating its coefficients and by verifying the results.

In the SGS agriculture is described by the intensities of the agricultural activities (technologies) for each of the subregions. Here each of the subregions is considered as one large farm. The technologies are characterised by the required inputs (water, fertiliser, labour and capital) and by the outputs (manure produced and earnings).

In this paper one aspect in the SGS, the employment in agriculture, is discussed. Chapter 2 describes the different categories of labour. The way in which these cotegories of labour are introduced into the first level model is described in chapter 3. In chapter 4 the actual situation in the Zuid Peel region with respect to labour is presented.

2. The description of the categories of labour

In agriculture there are two types of labour, regular labour and non-regular labour. Regular labourers are labourers that are employed in agriculture during the whole year. Non-regular labourers are employed during a part of the year, for instance during the harvest. A special kind of non-regular labour is the contractor. The contractor is hired, with his machine, to do a specific job.

In 1982 only 6 percent of the labourers in the Zuid Peel region were non-regular labourers (see table 4.1). With respect to the employment in agriculture this type of labour is not important because

- non-regular labour is required during specific (short) periods. Very often the earnings in agriculture are only additional.
- this type of labour is not scarce in the sense that it is available when it is required (scholars during holidays for instance).

As a consequence non-regular labour is not included explicitely in the first level model. However the cost of non-regular labour is taken into account in the calculation of the parameters of the first level model.

With respect to the contractor some remarks have to be made. In an approach at farmlevel the contractor is a part of the non-factor inputs and his labour is not considered as a part of the labour inputs at the seperate farms. In an approach as in the Scenario Generating System labour is aggregated at a (sub)regional level. In this case the contractor cannot be considered to be a part of the non-factor inputs any more because

- some activities are carried out by contractors at one farm and by regular labourers at another farm. The model however does not discriminate between seperate farms and the equipment and the labour have to be present in the subregion (in both cases). So both types of labour have to be handled in the same way.
- the contractor is very often a regular labourer at a private service institution in agriculture. In this case (in principle) they already belong to the employment in agriculture.

So in the Scenario Generating System the contractor is considered to be a regular labourer.

In the Scenario Generating System it is assumed that (regular) labouris available at the farm during the whole year. The labour requirements are expressed in man-years. The (implicit) assumption is made that the use of the labour is equally spread over the year and that, in the sparetime, the labour is used for (general) maintenance. Moreover it is assumed that a certain support of other technologies is allowed. This flexibilty is related to the fact that the (maximum) labour requirements of the different technologies do not coincide.

In this chapter only the difference between regular and non-regular labour has been discussed until now. But in the Scenario Generating System the difference between local

labour (i.e. the labour of the farmer and his family) and hired labour is of equal importance. Differences between local labour and hired labour are:

- local labour is more flexible with respect to working time than hired labour. It is assumed that the inputs of hired labour are according to the rules agreed with the labour unions. For local labour it is assumed that additional work is acceptable.
- hired labour is rewarded according to the agreements with the labour unions as the reward for local labour is an output of the model.
  This reward may be less or more than the reward for hired labour. This is possible because the local labourers are willing to accept a low income to secure the continuity of the farm. One of the reasons for this is that the local labourers own the capital and (sometimes) the land and they recieve its renumerations as well. Another reason is that they want to remain independent.
- hired labour is more 'mobile' than local labour. Here mobility includes both going to another (sub)region and changing to another farmtype. The low mobility of local labour is caused by the fact that the capital and (sometimes) the land are owned by the local labour. This hampers the transition to another (sub)region. Moreover the local labourers master only a limited set of technologies. So changing to another farmtype is limited too. Hired labour at the opposite has a high (potential) mobility because the mobility includes the replacement of one labourer by another one (in another subregion or with different abilities). This replacement does not bring about cost for agriculture.

Because of these differences hired labour and local labour are introduced as seperate variables into the Scenario Generating System.

3. The introduction of labour into the linear model.

Because of the differences between local labour and hired labour both of labour are introduced into the Senario Generating System. The types of labour differ in their attitude towards mobility and towards earnings (in agriculture). With respect to both types of labour constraints are formulated. In this respect it is important to realise that imposing seperate constraints for each of the subregions may have impacts on the intensities of the technologies that differ from the impacts in the case that constraints are imposed for the Zuid Peel region as a whole.

For local labour seperate constraints for each of the subregion are prefered because

- local labour is coupled to capital and (often) to land (which is not the case for hired labour). Because of this the mobility of local labour is low and the transfer to another (sub)region is expensive. Moreover putting constraints on local labour provides an opportunity to connect cost to the mobility of local labour.
- the combination of seperate constraints on the local labour per sub-region and one constraint on the employment in agriculture (incl hired labour) for the region as a whole provides the opportunity to have some variation (over the subregions) in income for local labour. There may for instance exist a region where the local labour exceeds the labour requirements (determined by the intensities of the seperate technologies). In this case (average) income will be low. At the same time there may exist a subregion with both local labour and hired labour. In this subregion the (average) income for local labour will be higher.
- the link between the Scenario Generating System and the second stage in the analysis (the Policy Analysis System) becomes more direct. In the Policy Analysis System sets of measures (policy alternatives) for the regional water management are analysed, taking into account the expected behaviour of the users of groundwater and surface water (for instance the farmers). These policies are generated by the RPMA in order to influence the behaviour of the users. In this respect the local labour (being the owner of capital and often also of land) is the group, in agriculture, that has to be influenced because it is the group that takes the decisions.

For hired labour no seperate constraint is formulated. Hired labour is constrained implicitely via the constraint on the employment in agriculture for the region as a whole.

The constraints with respect to labour that are included in the first level model are stated in the equations (3.1) through (3.5). In these equations the time index (t) is left out because it is not required in a steady state approach. Equation (3.1) describes the requirements of labour in subregion r stemming from the intensities of the technologies.

$$(3.1)\quad l(r) = \sum_j (lx(j).x(r,j)) + \sum_j (lz(j).z(r,j)) + lis(r).sc(r) + lig(r).sg(r)$$

In (3.2) the size of the hired labour in subregion r is calculated as the difference between the requirement of labour and the size of the local labour in region r. If the requirements are less than the lowerbound on local labour in region r, then local labour is equal to the lowerbound. In this case the size of the hired labour is equal to zero.

$$(3.2)\quad lh(r) \geq l(r) - la(r)$$

Equation (3.3) gives the upperbound and the lowerbound for the employment in agriculture for the region as a whole.

$$(3.3)\quad lmin \leq \sum_r (lh(r) + la(r)) \leq lmax$$

With respect to local labour the following constraints per subregion (3.4) and for the whole region (3.5) are introduced.

$$(3.4)\quad lamin(r) \leq la(r) \leq lamax(r)$$

$$(3.5)\quad lamint \leq \sum_r (la(r)) \leq lamaxt$$

The variables in these equations are

- l(r) - the demand for labour in subregion r
- la(r) - the size of local labour in subregion r
- lamax(r)- the size of upperbound on local labour in subregion r
- lamaxt - the upperbound on local labour in the whole region
- lamin(r)- the lowerbound on local labour in subregion r
- lamint - the lowerbound on local labour in the whole region
- lh(r) - the size of hired labour in region r
- lig(r) - the requirement of labour corresponding with one unit of sprinkling from groundwater
- lis(r) - the requirement of labour corresponding with one unit of sprinkling from suface water
- lmax - the upperbound on labour for the whole region
- lmin - the lowerbound on labour for the whole region
- lx(j) - the labour requirement corresponding with one ha of the landuse technology j
- lz(j) - the labour requirement corresponding with one unit of the non-landuse technology j
- sc(r) - the capacity for sprinkling with surface water in subregion r
- sg(r) - the capacity for sprinkling with groundwater in subregion r
- x(r,j) - the area with landuse technology j in subregion r
- z(r,j) - the intensity of non-landuse technology j in subregion r

This set of constraints is applied in the case of a steady state analysis. A steady state analysis is an analysis in which year to year changes are not taken into account. It is assumed that the process (or the generated state) is kept for an infinite number of years. In the Scenario Generating System the steady state analysis is applied in generating a 'target state'. In the evaluation of this target state (for instance in verifying its reachability) a (dynamic) analysis can be applied in which the year to year changes are considered as well.

If the development for a series of years is considered then another, alternative, set of constraints can be applied. In this set the labour-constraints at subregional level are replaced by constraints on the changes in the size of the local labour (for each subregion). Moreover in addition to these constraints some parameters may be introduced into the objective function (or the income equation) corresponding with the cost of replacement of local labour (capital etc.) to another subregion. The set of constraints is stated in the equations (3.6) through (3.10). The meaning of the variables has not changed, the index t refers to the year t. Equations (3.6), (3.7) and (3.8) correspond with (3.1), (3.2) and (3.3) respectively.

$$(3.6)\quad l(r,t) = \sum_j (lx(j).x(r,j,t)) + \sum_j (lz(j).z(r,j,t)) + lis(r).sc(r,t) + lig(r).sg(r,t)$$

$$(3.7)\quad lh(r,t) \geq l(r,t) - la(r,t)$$

$$(3.8)\quad lmin(t) \leq \sum_r (lh(r,t) + la(r,t)) \leq lmax(t)$$

The constraints (3.9) and (3.10) determine the boundaries for the development of the local labour in subregion r

$$(3.9)\quad la(r,t) \geq (1-rho).la(r,t-1)$$

$$(3.10)\quad lamint(t) \leq \sum_r (la(r,t)) \leq lamaxt(t)$$

The constant term rho (0 < rho < 1) corresponds with the highest possible rate of decrease of the local labour in each of the subregions. This rate (partly) depends on demographic factors. A rough estimate for rho (based on data for earlier periods) results in a value between .10 and .15 (for a period of five years).

4. The actual situation with respect to labour

In the description of the actual situation with respect to labour two sources are used:
- the survey with respect to the areas allocated to the different crops made by ICW in 1982. This survey, which covers the whole area of cultivated land, serves to
  . calculate the size of the area of cultivated land in each subregion
  . determine the area allocated to the different crops in each subregion.
- the data (for 1982) with respect to farmsize, area allocated to specific crops, numbers of animals, labour etc. for all farms larger than 10 SBE (a measure for the farmsize) with the buildings in the Zuid Peel area. These data are collected by the Netherlands Central Bureau of Statistics (CBS).

The CBS-data are linked to the survey to generate the required data for the subregions. It is assumed that the land of a farm is in the same subregion as its buildings.

Between the survey and the (transformed) CBS-data are differences in the calculated size of the areas. For the whole region these differences are presented in table 4.1. This table contains two columns for the CBS-data. The second one of these columns gives the cadastral area. Thisis the area with farm yards, small ditches etc. included. In the net area given in the first column the farm yards etc. are not included. The third column contains the area generated from the survey data. This area is comparable with the cadastral area.

table 4.1 Area of cultivated land in the Zuid Peel region (1982)

	CBS		ICW
	net area* (ha)	area (ha)	area (ha)
total	19689	21489	23820
with			
arable (excl maize)	1565		1597
maize	4619		6279
grassland	12141		13863
horticulture (open)	1249		1981
horticulture (glass)	115		99

* net area - this is the area without farmyards, ditches etc..

The differences between the survey data and the CBS-data are caused by:
- the fact that the survey covers the whole area of cultivated land (incl. small farms etc.) while the CBS-data are restricted to the farms larger than 10 SBE. This restriction results in a reduction (in the area covered) of about 10%. (The expected 10% reduction is based on data for other regions in the Netherlands).

- the farms with buildings inside the region and a part of the land outside the region and by farms with a part of the land inside the region and the buildings outside the region.
- measurement errors.

Because the difference in the total area (columns 2 and 3) in table 4.1 is about the expected 10%, it is assumed that the CBS-data covers allfarms (of more than 10 SBE) in the region. So it is not necessary to collect additional data about the farms with land inside the region and buildings outside the region.

table 4.2 The number of labourers in agriculture for the subregions

region number	labour						area (ha)
	regular labour				non-reg.	total	
	local>15	local<15	hired>15	hired<15			
1	38	7	3	1	0	49	275
2	158	13	18	0	4	193	883
3	49	2	5	0	2	58	375
4	68	13	4	0	1	86	408
5	113	13	5	1	4	136	589
6	44	6	0	0	0	50	280
7	105	8	14	0	3	130	580
8	37	2	1	0	5	45	431
9	180	21	20	1	9	231	1001
10	0	0	0	0	0	0	0
11	71	5	4	0	3	83	434
12	56	4	4	0	0	64	414
13	89	8	18	2	12	129	411
14	151	27	15	1	7	201	681
15	86	5	4	0	1	96	714
16	0	0	0	0	0	0	0
17	116	9	19	0	12	156	578
18	416	22	25	4	81	548	2432
19	234	16	74	1	22	347	1084
20	32	2	0	0	2	36	208
21	120	11	8	0	6	145	1256
22	45	2	2	0	0	49	182
23	172	7	9	0	2	190	1010
24	225	18	35	7	18	303	1789
25	100	7	3	0	4	114	724
26	74	9	5	2	5	95	492
27	36	3	3	0	4	46	273
28	321	15	61	1	41	439	2143
29	117	7	12	0	9	145	467
30	162	7	30	3	8	210	798
31	101	12	11	0	21	145	577
	3516	281	412	24	286	4519	21489

source CBS

For the subregions there are also differences between the calculated area and the area in the survey, but it is assumed that this does not have serious impacts on the labour requirements in the subregions. This is discussed (very short) at the end of this chapter.

Table 4.2 the number of labourers (regular and non regular) in the seperate subregions is presented. The area of cultivated land (the last column) is the cadastral area of the farms having their buildings in the subregion. In the Scenario Generating System only regular labour is considered. In the data this type of labour is split up into labourers working more than 15 hours a week and labourers working less than 15 hours a week. Because in the first level model labour is treated as full-time labour the figures with respect to labour, in table 4.2 have to be transformed into full-time labour.

Table 4.3 Full-time labour per subregion

region number	full-time labour local	hired	total	area (ha)
1	39.75	3.25	43.00	275
2	161.25	18.00	179.25	883
3	49.50	5.00	54.50	375
4	71.25	4.00	75.25	408
5	116.25	5.25	121.50	589
6	45.50	0.00	45.50	280
7	107.00	14.00	121.00	580
8	37.50	1.00	38.50	431
9	185.25	20.25	205.50	1001
10	0.00	0.00	0.00	0
11	72.25	4.00	76.25	434
12	57.00	4.00	61.00	414
13	91.00	18.50	109.50	411
14	157.75	15.25	173.00	681
15	87.25	4.00	91.25	714
16	0.00	0.00	0.00	0
17	118.25	19.00	137.25	578
18	421.50	26.00	447.50	2432
19	238.00	74.25	312.25	1084
20	32.50	0.00	32.50	208
21	122.75	8.00	130.75	1256
22	45.50	2.00	47.50	182
23	173.75	9.00	182.75	1010
24	229.50	36.75	266.25	1789
25	101.75	3.00	104.75	724
26	76.25	5.50	81.75	492
27	36.75	3.00	39.75	273
28	324.75	61.25	386.00	2143
29	118.75	12.00	130.75	467
30	163.75	30.75	194.50	798
31	104.00	11.00	115.00	577
	3586.25	418.00	4004.25	21489

source CBS

The transformation is based on the following assumptions:
- a labourer working more than 15 hours a week corresponds with a full-time labourer
- a labourer working less than 15 hours a week corresponds to 0.25 full-time labourer. In table 4.3 the full-time labour per subregion is presented.

As has been indicated before, there are differences between the (real) area of cultivated land in the subregion and the area presented in table 4.3. But these differences are such that the figures in table 4.3 are an acceptable approximation of the 'actual situation' with respect to labour. The factors taken into account are:
- the main differences between the survey and the CBS-data concern the area allocated to labour extensive crops (as grassland and maize). This means that these differences have a minor impact on labour.
- there are measurement errors in the data so (small) corrections in the labour data do not improve the accuracy.