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EMPLOYMENT POTENTIAL AND SOIL CONSERVATION WORKS IN U.P. HILLS—A LINEAR PROGRAMMING APPROACH

By

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INTRODUCTION

Ramganga dam has been constructed on river Ramganga in Uttar Pradesh to have irrigation and power. Due to erosion in hills a high load of silt is carried to the dam. Concern has been expressed in the recent past about deteriorating condition of the watershed in the Himalayan range resulting in rapid run-off. To prevent siltation of the reservoir, soil conservation measures have been taken up in the Ramganga catchment. Two soil conservation divisions, namely Ranikhet Soil Conservation Division and Ramnagar Additional Soil Conservation Division have been formed to carry out soil conservation works in the catchment of the Ramganga river.

THE CATCHMENT

Ramganga catchment is located between 30°6′ 36″ to 29° 33′ 10″ N latitude and 70°39′ 52.7″ to 78° 34′ 48″ East longitude containing 3136 km² as its area. It has 1030 km² (32 9%) under community lands (comprising of cultivable and uncultivable wastes and pastures) on moderate to steep slopes This 32 9% area does not include reserve forests.

River Ramganga originates at Dewanikhal and flows for 128 80 km before arriving at the proposed Kalagarh dam site. Its main tributaries as shown in the map are Birao, Khatraun, Gagas, Nain, Bagnagad. Mandal, Haldgad and Sonanadi. Ramganga and its tributaries flow over a variety of geological formations making what is known as middle Himalayas (1089 km²), outer Himalayas (1358 km²), Shiwalik (512 km²), Bhabar (177 km²) and zones of Kumaon Himalayas. The highest point in the catchment being at 2750 metres while the dam site is at 315 metres Siwaliks appear as a sudden rise from the neighbouring plains caused by the general young movement towards south and normal dip towards the Himalayas. The climate of the catchment varies from sub-tropical to temperate. The variation in climate is due to altitudinal change. Bulk of rainfall is

received during June, July and August months of the year from South West monsoon. Winter precipitation does occur during—December/January but less (about 50 mm) and is uncertain.

THE STUDIES

In the paper, soil conservation works and the corresponding employment potential has been discussed using a Linear Programming approach. Initial phase of the development work has been considered in this study. Subsequently an approach of Dynamic Programming has to be evolved to make room for other development. Soil Conservation Works taken up by the Forest Department in the catchment constitute forestry works, agricultural works and horticultural works.

These are :—

(i) *Afforestation works* :—Afforestation on waste lands is carried out. Plantation mainly of chir pine (*Pinus roxburghii*) (90% chir pine and 10% fodder species) is being raised.

(ii) *Agricultural works* :—On less slope areas fit for cultivation terracing and levelling is being done.

(iii) *Horticultural works* :—Planting of fruit trees on suitable sites is being carried out.

THE RESOURCES AND CONSTRAINTS

Various categories of area available for different activities are as under :—

Areas :—	(a)	Total area available for afforestation works	49 424 ha
	(b)	Total area available for agricultural works	47,647 ha
	(c)	Total area available for horticultural works	15,882 ha

Funds :—Annual budgetary grant for works Rs. 16,00,000

Expenditure :—Details of expenditure at the present level are :

(a)	Afforestation works	Rs. 1000 per ha
(b)	Agricultural works	Rs 2000 per ha
(c)	Horticultural works	Rs. 2000 per ha

Employment :—Labour requirement per unit area per annum for each activity is as under :

(a)	Afforestation works	150 man days per ha
(b)	Agricultural works	200 man days per ha
(c)	Horticultural works	100 man days per ha

Wages of each mazdoor have been taken as Rs. 5.00 per day. Skilled and unskilled manpower have not been separated. The man days shown above include supervisory staff also. Their wages have been taken in terms of unskilled labour units.

Costs and Benefits:—Costs and benefits per unit have been worked out and shown in Table—A below.

Table A

Activity	Labour requirement (including supervisory staff		Misc. expenditure Rs.	Total expenditure Rs.	Benefits* Rs	Net Revenue or loss
	Man days	Cost @ Rs 5/= per man per day				
Afforestation (per ha)	150	750	250	1000	1500	500
Agriculture (per ha)	200	1000	1000	2000	240	—1760
Horticulture (per ha)	100	500	1500	2000	3000	1000

*Indirect benefits such as soil protection, water control, amenity, recreation, etc. have not been considered as these could not be quantified.

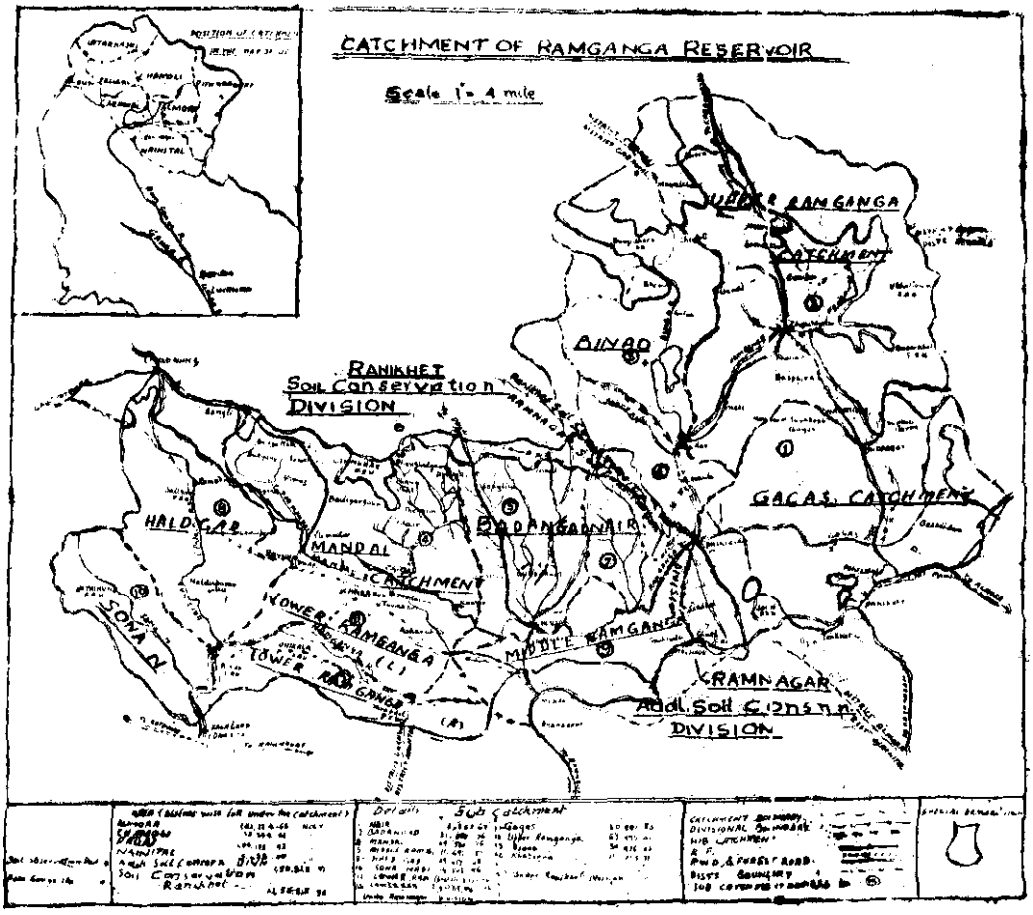
THE LINEAR PROGRAMMING MODELS

Annual targets for different categories of works mentioned above i.e afforestation, agriculture and horticulture are being fixed arbitrarily without considering the costs and benefits, the resources available and constraints present. A Linear Programming approach provides a more rational basis to fix various targets keeping in view the objectives of the project. Taree separate MODELS have been studied for different objectives.

Model 1 The objective function is to maximise the revenue with the constraint that at least 500 men are provided with the employment throughout the year (about 1,80,000 man days).

Model 2. The objective function is to provide the maximum employment with the constraint that the entire project is worked on no loss and no profit basis. Revenue is not the main consideration.

Model 3. The objective function is to provide the maximum revenue with the constraint that employment is provided to at least 500 men throughout the year (1,80,000 man days). There is another constraint that a minimum area under each category viz. afforestation, agricultural and horticultural work is to be attended so that the entire area available is treated in a coordinated way.


CATCHMENT OF RAMGANGA RESERVOIR
Scale 1"= 4 mile
RANIKHET
Soil Conservation
DIVISION
AINRO
GAGAS CATCHMENT
HALDGAR
MANDAL
RAMGANGA DAM
SOMA N
LOWER RAMGANGA
MIDDLE RAMGANGA
RAMNAGAR
Addl. Soil Conservation
DIVISION

MODEL—1 APPROACH

Objective function

To achieve maximum revenue.

Subject to the constraints

(i) Employment is to be provided to at least 500 men throughout the year (about 1,80,000 man days).

(ii) Total available annual budgetory grant not to exceed Rs. 16 00,000.

(iii) The maximum areas available for the three categories are :

(a)	Afforestation	49,424 ha
(b)	Agriculture	47,647 ha
(c.	Horticulture	15 882 ha

The model in the form of matrix is given Table 1 1.

Table 1 1

Maximum revenue with a minimum number of man days

Constraints	Activities				
	Afforestation	Agriculture	Horticulture	Cost	
Revenue (Rs.)	1500	240	3000	—1	Maximize
1. Employment (man days)	150	200	100		⩾1,80,000
2. Costs (Rs.)	1000	2000	2000		⩽16,00,000
3. Max. afforestation	1				⩽49,424
4. Max. agricuture		1			⩽47,647
5. Max. horticulture			1		⩽15,882

Putting slack and identity variables to have inequalities as equalities, the optimum solution was obtained with the help of a computer programme developed by the author and run on Honey Well-400 Computer of O N G C., Dehra Dun. The activities which maximizes the objective function are shown in Table 1.2.

Table 1 2

Value of activities which leads to maximum revenue objective function

Activity	Unit	Value
1. Afforestation	ha	1000
2. Agriculture	ha	Nil
3. Horticulture	ha	300

MODEL—2 APPROACH

Objective function

To provide maximum employment.

Subject to the constraints

(i) Anticipated revenue should not be less than the expenditure of the project.

(ii) The maximum area available for :

(a)	Afforestation	49,424 ha
(b)	Agriculture	47,647 ha
(c)	Horticulture	15,882 ha

The above model in the form of the matrix is given in Table 2.1

Table 2.1

Maximum employment potential

Constraints	Activities				
	Afforestation	Agriculture	Horticulture	Cost	
Employment (man days)	150	200	100		Maximize
1. Revenue (Rs.)	1500	240	3000	—1	= 0
2. Costs (Rs.)	1000	2000	2000		⩽16,00,000
3. Maximum Afforestation	1				⩽49,424
4. Maximum Agriculture		1			⩽47,647
5. Maximum Horticulture			1		⩽15,882

Using slack and identity variables to have inequalities as equalities, optimum solution was obtained with the help of a computer programme run on Honey-Well 400 Computer of O.N.G.C., Dehra Dun. The activities which maximises the employment potential are shown in Table 2.2

Table 2.2

Values of activities with maxmizes employment

Activity	Value (ha)
1. Afforestation	1020
2. Agriculture	290
3. Horticulture	—

MODEL—3 APPROACH

Objective function

To achieve maximum revenue

Subject to the constraints

(i) Employment is to be provided to at least 500 men throughout the year 1,80,000 man days).

(ii) Total available annual budgetary grant not to exceed Rs. 16 00 000.

(iii) Minimum target to be taken up for each category is as under:

(a)	Afforestation works	980 ha
(b)	Agricultural works	40 ha
(c)	Horticultural works	40 ha

MODEL 3 in the form of matrix is given in Table 3.1

Table 3.1

Maximum revenue with a minimum number of man days and a prelaid down minimum target under different activities

Constraints	Activities				
	Afforestation	Agriculture	Horticulture	Cost	Maximize
Revenue (Rs.)	1500	240	3000	—1	
1 Employment (man days)	150	200	100		$\geqslant$1,80,000
2. Costs (Rs.)	1000	2000	2000		$\leqslant$ 6,00 000
3. Max. afforestation	1				$\leqslant$49 424
4. Min. afforestation	1				$\geqslant$980
5 Max. agriculture		1			$\leqslant$47,647
6. Min. agriculture		1			$\geqslant$40
7. Max. horticulture			1		$\leqslant$15,882
8. Min. horticulture			1		$\geqslant$40

In this table, slack and identity variables were used to have inequalities as equalities and the optimum solution was obtained with the help of a computer programme run on Honey-Well 400 Computer of O.N.G.C., Dehra Dun. The activities which maximizes the objective function i.e. revenue are shown in Table 3.2.

Table 3.2

Values of activities which leads to maximum revenue objective function

Activity	Unit	Value
1. Afforestation	ha	980
2. Agriculture	ha	40
3. Horticulture	ha	270

DISCUSSION

Model 1. It achieves a maximum revenue of Rs. 8,00,000. In this approach the two activities which are to be carried out are afforestation and horticultural works. This suggests that the available resources should be utilised for these activities.

Model 2. This approach of no profit and no loss basis provides employment of 2,11,014 man days. The model suggests that afforestation and agricultural works need be carried out to achieve the above objective function

Model 3. This approach of a prelaid down minimum target suggests that more areas under horticultural works may be taken up. However, in this case the maximum revenue is Rs. 6,89,600.

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SUMMARY

A linear programming approach for allocation of resources to attain specific objectives has been discussed. Three models for different objectives with varying constraints have been considered with special reference to the problem of Soil Conservation Works carried out in the catchment areas of river Ramganga in Uttar Pradesh hills.

उत्तर प्रदेश पर्वतीय क्षेत्र की रोजगार देने की क्षमताएं तथा मृदा संरक्षण कार्य
रेखीय कार्यक्रमण दृष्टि से

लेखक आर० पी० शर्मा

सारांश

इस लेख में कुछ विशिष्ट उद्देश्यों की पूर्ति के लिए संसाधनों के नियतन में रेखीय कार्यक्रमण दृष्टि अपनाने पर विचार किया गया है। इसमें उत्तर प्रदेश के पर्वतीय भाग की रामगंगा नदी घाटी परियोजना के जलग्रह क्षेत्र में किए जा रहे मृदा संरक्षण कार्यों की समस्याओं के विशेष संदर्भ में तरह तरह के निबाधन अपनाते हुए विभिन्न उद्देश्यों के लिए तीन प्रारूपों पर विचार किया गया है।

Beschäftigunges Potential und Bodenerhaltungarbeiten im Up Gebirge—
Eine lineare programmende Annäherung

R.P. SHARMA

ZUSAMMENFASSUNG

Man hat eine lineare programmende Annäherung nach *Verteilung die Hilfsquellen*, die spezifische Zielen zu erreichen, diskussiert. Drei Modellen werden um verschiedenen Zielen bei verschiedenen Zwangen, mit spezifischer Beziehung zu den Bodenerhaltung-*problemen der Arbeiten in Stromgebiet des Fußtal Ramganga Projekts im UP Gebirge*, betrachtet.

Potentiel d'emploi et les travaux de la protection du sol dans les mon
fagues de l'Uttar Pradesh

par R.P. SHARMA

Résumé

Cette étude avait pour objet d'allouer par la programmation la linéaire, les ressources dans le but d'atteindre certains objectifs déterminés. Trois differents modèles, correspondant à divers objectifs à des contraintes différentes ont été considérés, Ce travail se rapporte, particulièrement, au problème de la protection du sol dans le bassin d'alimentation de la riverè Ramganga, dans le montagnes de l'Uttar Pradesh.

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