*Netherlands Journal of Agricultural Science 33 (1985) 161-166*

# Priority listing for resource allocation: a method based on competitive influences between population centres

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*Key words:* resource allocation, wood energy

**Abstract**

A method is described which permits the identification of competition levels between population centres when the inhabitants collect a scarce resource, such as fuelwood, in the area and around their population centre. These levels are assessed quantitatively. A ranking of these levels indicates where competition is most severe and where action, e.g. fuelwood planting, is most needed. The development of the method found its origin in the fact that funds and manpower needed in solving a regional energy problem are restricted and should be allocated first of all there where assistance is most needed.

## Introduction

To those who are responsible for resource management, scarcity of a resource will always pose the question of allocation. It has been documented (e.g. Taylor & Soumaré, 1984; Spears, 1984) that a great number of forestry projects are being executed around the world that aim principally at increasing the wood energy supply. Most of these projects are in the developing countries. Current estimates are that annually some US$ 200 million in external aid is being used to support Third World forestry. Some 40 % of this is for fuelwood production projects. Nevertheless, a five-fold increase in investment appears necessary if sufficient forest products and services are to be generated by the year 2000 (Spears, 1984). Clearly, despite high levels of foreign aid, financial resources can be considered scarce.

## The allocation issue

Consider a rural area experiencing a fuelwood shortage, where a project is to start aiming at improvement of the energy situation in the area. The project area is usually well defined and may coincide with political or watershed boundaries. In the project area are a number of villages, each facing fuelwood problems.

First of all, an energy balance should be established to quantify the energy situation in the area. This would require data on energy production and energy imports, on the one hand, and on energy consumption, energy losses, energy exports and the deviation of energy carriers to non-energy purposes on the other hand. A negative saldo on the second side of the balance indicates a shortage. Local shortages may exist even when the two sides are in balance.

This is followed by a study of options on supply increase and demand reduction, including the use of alternative energy sources.

Assuming that the increase of the fuelwood supply will become a major project goal for which funds and expertise are to be allocated, the question is then: where to start?

Apart from political issues and the physical suitability of the land, a reasonable answer could be to start where the problems are gravest. Unfortunately, tree planting can take place only to a very limited extent within population centres themselves. Most afforestation work will therefore have to be executed outside the village. It is at this outside land where competition may occur because of the presence of one or more nearby other villages. In other words, the needs of those other villages will have to be taken into account at the first planning stage.

An important aspect is that such nearby villages may be situated outside the defined project area.

A method which indicates the degree of expected competition between population centres, both within and outside the project area, will now be outlined. The relative importance of the competition can be used to make a ranking list for priority action.

## The principle of the method

The inhabitants of a population centre usually collect their fuelwood in a circular area around the centre. The size of the area depends on the number of fuelwood-collecting inhabitants, the available amount of fuelwood in the area, the fuelwood need per person and the maximum distance people travel to collect wood (if on foot, this distance rarely exceeds 15 km).

The number of fuelwood-collecting people and the collecting area result in a mean density of people per unit area.

If two nearby centres are considered, having a different number of fuelwood-collecting people, it is assumed that circular collecting areas around each centre will develop. At a given moment (more people, less fuelwood), the circles describing these areas will touch each other. Equilibrium will exist when two circular areas have developed in which the mean density of people per unit area is the same within both circles touching each other.

In mathematical form: given two population centres with N and M fuelwood-collecting inhabitants, respectively, and a distance D between the centres; the N people collect their fuelwood in an area with radius R, the M people in an area with radius S. Mean population densities are then:

$N/(\pi \times R^2)$ and $M/(\pi \times S^2)$

Touching circles require that:

$S = D - R$

Equilibrium exists when:

$$N/(\pi \times R^2) = M/(\pi \times (D-R)^2)$$

This equation can be solved for R. There are in fact two solutions, the one significant for the present method being:

$$R = (2 \times N \times D - ((2 \times N\,D)^2 - 4(N-M) \times N \times D^2)^{1/2})/2(N-M)$$

After calculating R, the mean density can be calculated. Fig. 1. illustrates the principle.

This procedure is repeated for all possible pairs of population centres. In practice only those pairs should be considered where competition is possible, that is:
- people of a population centre who do collect fuelwood
- the distance between the pair is less than twice the maximum distance people travel.

For the pairs of population centres considered, a list of population densities is thus developed. A high density value indicates a high degree of expected competition. Based on the density values, a ranking can then be made, indicating in turn a listing of priorities for action.

This should be followed by verification with field visits or aerial photographs to check whether barriers exist between any pair of population centres which would prevent direct communication between them, such as rivers, escarpments, or swamps. In such cases, the corresponding density values should be removed from the priority list.

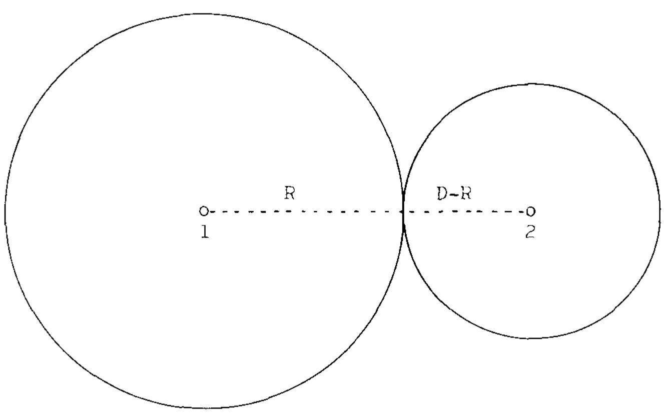


Fig. 1. Two population centres, numbered 1 and 2, with 310 and 140 inhabitants respectively. The distance between the centres on the map is 6.1 cm.

R (of population centre 1) = 3.65 cm is now calculated. D-R is thus 2.45 cm. The mean population density in each circle is then: $310/\pi \times 3.65^2) = 7.41$ inhabitants per $cm^2$ map.

## Discussion

A number of assumptions as well as the availability of certain data underly the applicability of the method.

The assumptions are:

- there is a fuelwood shortage in the area
- the population is concentrated in defined population centres
- the area is uniformly productive and accessible
- people collect fuelwood in a circular area around their population centre
- a single means of transportation is used.

Necessary data are:

- number of fuelwood-collecting people per population centre
- distances between any two population centres
- maximum distance people travel to collect fuelwood.

The assumptions made need some comments. First, the fuelwood shortage, which can be local, is to be determined, aided by the energy balance for the area. Second, the method cannot be used for a dispersed or nomadic population. If nomadic tribes interfere in areas with a sedentary population, the method is still applicable if the nomadic pressure is uniform over the area. Third, not all areas are uniformly productive. It should be realized, however, that this uniformity varies with the scale at which planning is carried out. Productivity may be very variable when determined per ha but may be nearly uniform when assessed per $km^2$. An area study will reveal whether the assumption is valid. The same study will also make clear whether the accessibility can be considered uniform. Especially at this stage, field visits are required. Clearly, accessibility depends on the means of transportation: on foot, by bicycle, animal, etc. Finally one could apply the method, determine the ranked listing and verify in the field or on aerial photographs whether there is proof that the found ranking is indeed the proper one.

If the number of population centres is not too large, all calculations can be carried out by pocket calculator. Large numbers can be better handled by computer. In this case, coordinates of population gravity centres can be used to automate the entire procedure. Plotting devices can produce maps, complete with ranked locations for priority action.

In addition to the ranking of expected competitive effects on an area base, the method also determines, per population centre, the relative competition from surrounding villages.

An example in Appendix I shows both aspects of the method. It should be emphasized that the calculated density values themselves have only a theoretical meaning in the context of this method. It is their relative place on the ranking list that determines their importance.

More refinements can be conceived quite easily. One should be prudent, however, and avoid increase in local precision at the expense of regional validity. One refinement that can be mentioned is that if this method is used for setting priorities on local afforestation efforts, available growth rates for individual population centres (census data) can be used in forecasting the number of wood collecting people at the end of the first rotation period. The method should then be based on these numbers.

## Conclusion

The method provides a simple way to aid in the allocation of scarce resources by means of priority listing, assessed quantitatively. Although the method was developed for planning fuelwood planting locations, applications in other fields are possible as long as quantifiable radially operating influences exist, which in principle are mutually exclusive.

## References


Spears, J. S., 1984. Role of forestation as a sustainable land use and strategy option for tropical forest management and conservation and as a source of supply for developing country wood needs. In: K. F. Wiersum (Ed.), Strategies and designs for afforestation, reforestation and tree planting, p. 29-47. Pudoc, Wageningen, Netherlands.

Taylor, G. F. & M. Soumaré, 1984. Strategies for forestry development in the semi-arid tropics: Lessons from the Sahel. In: K. F. Wiersum (Ed.), Strategies and designs for afforestation, reforestation and tree planting, p. 137-167. Pudoc, Wageningen, Netherlands.


## Appendix 1. An example of the method

Given four population centres, numbered 1 to 4, with the following number of inhabitants:

| | |
|---|---|
| 1 | 414 |
| 2 | 257 |
| 3 | 280 |
| 4 | 199 |

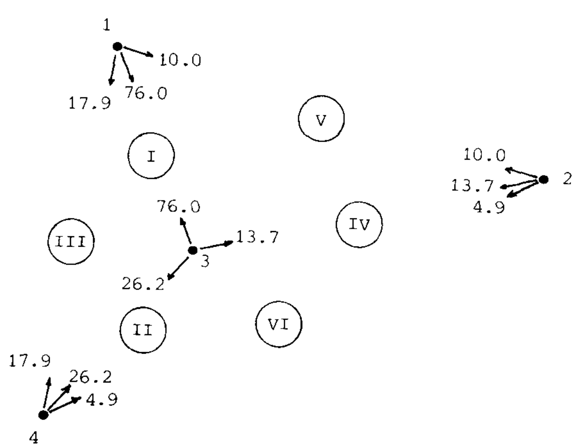


Fig. 2. Densities and ranking values based on example in Appendix 1.

The distances between the population centres were determined on a map (in cm) and are shown in the following table:

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | – | 6.5 | 2.4 | 4.6 |
| 2 | | – | 5.0 | 7.7 |
| 3 | | | – | 3.4 |
| 4 | | | | – |

The equilibrium densities can now be calculated; e.g. for centres 1 and 3, the value of R (for centre 1) is 1.3 cm. This results in a mean equilibrium density of:

$414/(\pi \times 1.3^2) = 76.0$ inhabitants per $cm^2$ map.

Similarly all other combinations can be calculated. The ranking of the calculated densities is then to be done.
The results are shown in Fig. 2, where densities are in arabic numbers and the ranking values in roman numbers.