A MATHEMATICAL MODEL FOR THE EVALUATING OF QUALITY OF THE PLANTATION FOREST IN VIET NAM

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Abstract

We consider N ecosystems with m indicators.
A problem will be arisen which system is the best and which the systems are following. In the case of m = 1, it is easy to check, but if $m \geq 2$, it will be difficult to solve that. The solution of problem is obtained in this paper with the mathematical model. An example of the systems of plantation forest in Northern Vietnam is given for the illustration of the method.

Problem

We must plant a number of trees in the mountains of Vietnam with WFP.But which tree and which set of tree together will be choosed.There is many variants of the trees. The variant includes agricultur trees and forestry trees is called the combination agroforestry variant In the passed years we planted many experiments of the combination agroforestry variants. Now a problem is apeared how to assess those variants. That means how to find the optimal variant and the hierarchical consequence of the variants.Then the optimal variant will be choosed to the demonstration variant for all country.
In recent years, there is many methods to evalue the variants. But they are depending on the experiences of the expert of ecology, agriculture, forestry and policy maker. Now we give a new method upon the mathematical models.

The Modelling

We consider N systems (that means N combination agroforestry variants), with m indicators. For example:
the economical effect,
the exchange of quality of soil,
the erosion degree, and
the microclimat improvement,......
Data will be gathered in following table :

$$X = \begin{bmatrix} X11 & X12 & \dots & X1N \\ X21 & X22 & \dots & X2N \\ \dots & \dots & \dots & \dots \\ Xm1 & Xm2 & \dots & XmN \end{bmatrix} \qquad (1)$$

where Xji is the varied value of indicator j of system i from begining to present, $j = 1 \rightarrow m$, $i \rightarrow N$.

Step 1 :
Set up a real transformation Z(Xji) from ($R(-\infty,+\infty) \times \Omega$) into R(0,1). where $R(-\infty,+\infty)$ is the values of indicators, Ω is the dimension of indicators.

If the value max Xji with $1 \leq i \leq N$ is the ideal case , then put the real transformation (see/5/)

$$ZJI = Z(Xji) = \frac{Xji - \min Xji}{\max Xji - \min Xji} \quad (2)$$

If the value min Xji with $1 \le i \le N$ is the ideal case , then put the real transformation

$$Zji = Z(Xji) = \frac{Xji - \max Xji}{\min Xji - \max Xji} \quad (3)$$

We have now the new table

$$Z = \begin{bmatrix} Z11 & Z12 & \ldots & Z1N \\ Z21 & Z22 & \ldots & Z2N \\ \ldots & \ldots & \ldots & \ldots \\ Zm1 & Zm2 & \ldots & ZmN \end{bmatrix} \quad (4)$$

Step 2:

Calculate the weight of indicator j denoted αj (the importance proportion coefficience of indicator j in m indicators of N systems)(see/6/)

$$R1 = (r1, hi) = \frac{\sum_{i=1}^{N} (Xhi - Xh.)(Xji - Xj.)}{(\sum_{i=1}^{N} (Xhi - Xh.)*2 \sum_{i=1}^{N} (Xji - Xj.)*2)^{1/2}} \quad (5)$$

then find the maximum of all following expressions with $1 \le j \le m$,

$$\max_{1 \le j \le m} \frac{\sum_{h=1}^{m} (r1, hj)*2}{(r1, jj)} := sm1 \quad (6)$$

and remark the location of indicator m1.
Then calculate matrix Rk with k=2...m,

$$Rk = (r(k, hj)) = (r(k-1, hj)) - \frac{(r(k-1, hm1))((r(k-1, jm1))}{(r(k-1, m1m1))} \quad (7)$$

then find the maximum of all following expressions with $1 \le j \le m$,

$$\max_{1 \le j \le m} \frac{\sum_{h=1}^{m} (r(k, hj))*2}{r(k, jj)} := smk \quad (8)$$

and remark the location of indicator mk.
Finanly obtains αmk, $k=1 \rightarrow m$:

$$\alpha mk := \frac{smk}{\sum_{k=1}^{m} smk} \quad (9)$$

Step 3

Calculate the score of the systems $i = 1 \rightarrow N$: (see/1/,/2/)

$$Zi = \sum_{j=1}^{m} (\alpha j)(Zji) \quad (10)$$

Step 4

We make the rank of all systems according to the score of each system

$$Z1 \geq Z2 \geq Z3 \geq \ldots\ldots \geq ZN \qquad (11)$$

Then Z1 is the optimal system in N systems. The following systems are Z2 , Z3,....., ZN.

The uniform optimal criterion

The consequence (11) is deduced according to the scores of all systems.

We consider not yet the role of the indicators. May be there is the optimal system, however it has the very bad indicator.So we develop the new concept uniform optimal criterion.(see/3/,/4/)

Definition

The system i1 is called the optimal degree γ ($1 \leq \gamma \leq N$), if satify

$$Zi1 = \max Zi\ ,\ 1 \leq i \leq N, \qquad (12)$$

with the conditions $Zji1 \geq \gamma$; $\forall j$; $1 \leq j \leq m$.

Proposition

Let N systems with m indicators finite. Then there exists always an algorithm to find the uniform optimal system and the hierarching consequence of rest systems.

The algorithm is as follow:

Step 1 :

We make the order for the indicator j in all systems i : $1 \leq i \leq N$.

For exampl $Xj1 \geq Xj2 \geq Xj3 \geq \ldots\ldots \geq XjN$.

The order of indicator j of system i is denoted by Vji.

Then we have the matrix of orders :

$$V = \begin{bmatrix} V\,11 & V\,12 & \ldots & V\,1\,N \\ V\,21 & V\,22 & \ldots & V\,2\,N \\ \ldots & \ldots & \ldots & \ldots \\ Vm\,1 & Vm\,2 & \ldots & VmN \end{bmatrix} \qquad (13)$$

By the integer transformation from R(1,N) to R(N,1)

$$Gji = N - Vji + 1 \qquad (14)$$

is obtained the following new matrix of integer values

$$G = \begin{bmatrix} G_{11} & G_{12} & \ldots & G_{1N} \\ G_{21} & G_{22} & \ldots & G_{2N} \\ \ldots & \ldots & \ldots & \ldots \\ G_{m1} & G_{m2} & \ldots & G_{mN} \end{bmatrix} \qquad (15)$$

Step2 :
Calculate αj ; $1 \leq j \leq m$ (see 2)
Step 3: calculate the score of system i , i=1,..N :

$$Hi = \sum_{j=1}^{m} (\alpha j) Gji \qquad (16)$$

Step 4:
The first let γ =N then find the optimal Hi1,
The second let γ =N-1 find the optimal Hi2 among the rest systems.
Continue to the end with γ =1.
Then we have the uniform optimal consequence:
Hi1,Hi2,.....HiN ,
where Hi1 is the best, then follow Hi2,Hi3.... HiN.

Application
With the same soil we consider 6 variants E1,E2,...E6 with 6 species of tree :
E1 : Australian Eucallyptus,
E2 : Nghiabinh Eucallyptus,
E3: Excerta Eucallyptus,
E4: Acacia auriculiformis,
E5 : Acacia mangium,
E6 : Manglitia.
The problem is how to find the best rational specie for this region.
Indicators are choosed as follow
Indicator 1 : P2O5
Indicator 2 : Hidrelie Acidity
Indicator 3 : Height of tree
Indicator 4 : Diameter of tree.
We have the data table :

Tree .... Indicator	E1	E2	E3	E4	E5	E6
1	O.14	0.15	0.16	0.15	0.18	0.15
2	11.4	6.4	9.1	12.7	15.3	14.2
4	2.01	1.14	1.14	1.21	1.59	1.63
4	1.0	1.14	2.0	1.0	3.6	1.9

The weight αj are calculated as follow:

$$\alpha = \begin{bmatrix} \alpha 1 \\ \alpha 2 \\ \alpha 3 \\ \alpha 4 \end{bmatrix} = \begin{bmatrix} 0.0296 \\ 0.1396 \\ 0.3062 \\ 0.5246 \end{bmatrix} \qquad (17)$$

* By the method of uniform optimal criterion we have the following matrix:

$$G = \begin{bmatrix} 1 & 2 & 5 & 2 & 6 & 4 \\ 3 & 1 & 2 & 4 & 6 & 5 \\ 6 & 1 & 1 & 3 & 4 & 5 \\ 1 & 3 & 5 & 1 & 6 & 4 \end{bmatrix} \qquad (18)$$