Bat Algorithm to improve a Financial Trust Forest

Alberto Ochoa¹, Lourdes Margain², Alberto Hernández³, Julio Ponce⁴,
¹Juarez City University, México
²Universidad Politecnica de Aguascalientes, México
³Morelos University, México
e-mail: alberto.ochoa@uacj.mx

Abstract— A controversial topic and frequently in public policy analysis is related with temporality in projects with limited funds associated with natural resources. Public resources can be organized as a Financial Trust. Very often the relationship between the budgets requested and can be received is overwhelming, as it is very unlikely to be as necessary as that can be awarded. In addition, strategic approaches, political and ecological considerations permeate the decision-making on such assignments. To meet these regulatory criteria, underlying any prevailing public policy or government ideology, it is clear that both must be appropriate to prioritize the development projects in ecological project portfolios, these must be consistent with principles sound (for example, maximization of social benefits in the future).

Computation so using novel bioinspired algorithms (In this case a Bat Algorithm) can be characterized as follows:

• They can be no doubt profitable, but its benefits are indirect, perhaps only in the long run may be visible and difficult to quantify.
• Apart from its potential contribution to economic welfare, are not intangible benefits in the present, which must be considered to achieve a holistic view of their ecological and social impact.
• Equity in relation to the magnitude of the impact of a specific project and social conditions of the beneficiaries should also be considered.

In the present study was conducted using an approach to intelligent optimization problem for a Financial Trust Forest in Chihuahua.

Keywords: Bat algorithm; financial trust forest; decision support system using interactive maps.

I. INTRODUCTION

Chihuahua, the largest state of Mexico is north of its geography, is the state with the largest forest area, as it has 7,591,842 ha which represents 13.2% of the national total, but 71% of the state territory is considered suitable for forestry because of its low population density rural (4 hab/km2). This area extends from north to south in a stretch of 850 km from the town of Janos until Guadalupe and Calvo, and includes a total of 30 municipalities. But in terms of timber stocks, ranked second nationally, with 14% of the total, because it has 266,112.404 m³ with a current annual increment of 4 million m³[1].

The high rates of productivity and enabling environment have attracted investment from pulp and paper producers in regional and global and European investors recently, including forestry investment funds (FIF). Chihuahua has a potential forest but will be improve specify a financial trust with economical planning horizon.

FAO stresses the following characteristics of forest plantations in the region.

• The investment in technology to improve productivity, especially clonally propagation;
• The use of fast-growing species such as Eucalyptus spp., Pinus radiata, and Pinuselliottii Pinustaeda, intensively managed;
• The integration of plantations on wood processing, and with the preparation of cellulose pulp.

FAO projections forecast that 12.7 million increases cultivated in 2007 to 17.3 million hectares in 2020.

According to FAO [1], the main long-term drivers of demand to 2030 are:

• Demographic changes. The world population will increase from 7.1 billion in 2012 to 8.2 billion in 2030.
• Economic growth. Is expected to double global gross product in 2030.
• Differential Growth in developing economies, especially Asia and Latin America.
• Stricter environmental regulations that exclude forested areas, including forests. Emergency tree plantations as a primary resource.

Increased use of renewable energy from biomass and forest.

In lumber and specialized wood, FAO expects world growth of 1.4% per year in consumption by 2030, with higher rates in Africa and Asia compared with North America and Europe. Meanwhile for the panels, FAO expects even higher growth, of around 3% on average and annual rates of 4.5% in Asia, consolidates the trend towards the use of particleboards and fiberboards replacing the Plywoods. For pulp and paper, the agency also provides a sustained growth nearly 3% global average, with figures of 4% in Asia and Africa.

In regard to technological advances in forestry two areas:

1) forest management and production resources and environmental services.
2) harvest, transport and processing of timber.

In these areas development objectives tend to reduce costs and increase productivity, develop new products and services, conserve resources and reduce environmental impacts and increase energy efficiency. In all these fields, biotechnology, nanotechnology and information technology continue to impact the industry significantly. To cite an example, there have been recent efforts in mapping the
the rate of pulse emission which is described in the next section.

are initialized for each bat

are initialized for each bat. For each time step \( t \), being \( T \) the maximum number of iterations, the movement of the virtual bats is given by updating their velocity and position using Equations 1, 2, and 3, as follows:

\[
\begin{align*}
    f_i &= f_{\text{min}} + (f_{\text{min}} - f_{\text{max}}) \beta, \quad (1) \\
    v_{ji}(t) &= v_{ji}(t-1) + \left[ x_{ji} - x^{(t)}_{ji} (t-1) \right] f_i, \quad (2) \\
    x_{ji}(t) &= x_{ji}(t-1) + v_{ji}(t), \quad (3)
\end{align*}
\]

where \( \beta \) denotes a randomly generated number within the interval \([0, 1]\). Recall that \( x_{ji}(t) \) denotes the value of decision variable \( j \) for bat \( i \) at time step \( t \). The result of \( f_i \) (Equation 1) is used to control the pace and range of the movement of the bats. The variable \( \beta \) represents the current global best location (solution) for decision variable \( j \), which is achieved comparing all the solutions provided by the \( m \) bats. In order to improve the variability of the possible solutions, Yang [2] has proposed to employ random walks. Primarily, one solution is selected among the current best solutions, and then the random walk is applied in order to generate a new solution for each bat that accepts the condition in Line 5 of Algorithm 1:

\[
x_{new} = x_{old} + eA(t),
\]

in which \( A(t) \) stands for the average loudness of all the bats at time \( t \), and \( e \in [-1, 1] \) attempts to the direction and strength of the random walk. For each iteration of the algorithm, the loudness \( A \) and the emission pulse rate \( r \) are updated, as follows:

\[
A(t+1) = \alpha A(t), \quad r(t+1) = r(t)[1 - e^{\alpha - r(t)}],
\]

where \( \alpha \) and \( r \) are ad-hoc constants. At the first step of the algorithm, the emission rate \( r(0) \) and the loudness \( A(0) \) are often randomly chosen. Generally, \( A(0) \in [1, 2] \) and \( r(0) \in [0, 1] \) [2]. Bat Algorithm is very different from PSO Algorithm because specify better casual minor variations when is affected by exogenous events [2]. In addition we compare the results of another novel research as Wolf Search Algorithm [8] and ideas form a proposal of Okapi Algorithm.

II. DEVELOPMENT OF A FINANCIAL TRUST FOREST IN CHIHUAHUA

They have modeled growth curves for both species as different potential average annual increases (IMAS). The following figure 1 shows an example which gives the intelligent software modeling algorithm based on both bat species E. grandis and E. dunii certain IMAs. Broadly speaking, the model calculates the following:

* E. dunii: an increase in the growth \( 1 \text{m}^3 \) 9\text{m}^3 \) of aue ntio

* E. grandis: 1\text{m}^3 increased growth in the IMA results in 15\text{m}^3 of increased production per hectare.
Final harvest
Harvest or final felling is a year 9 in the case of E. dunii year and 18 for the E grandis. Considering the project is estimated IMAs or volume of 197m³ for the final harvest of 322 m³ first and the second.

In both cases there is a pre-harvest inventory. In E. dunii sprouts are handled after harvest for the second cycle is performed at this stage control and stump sprouts in E. grandis. These species will be cultivated to realize the future project according the analysis of Chihuahua government.

III. INTELLIGENT TOOL TO SUPPORT THE PROPOSED DECISION MAKING BUSINESS PLAN.

Business objectives seek close trade agreements for the sale of timber as possible optimizing prices and diversification, with recognized operators and insurance.

This project proposed for the Chihuahua government plans to produce 2.7 million m³ to market:

* 1.7 million m³ of E. grandis, 1.0 million m³ for E. dunii.
* 2 million m³ to 0.7 million pulp and sawlogs.

Certified Emission Reductions
Forest plantations sequester CO2 from the atmosphere thus contributing reduce the greenhouse effect. It is for this reason that, properly designed, forestry projects may be eligible for Clean Development Mechanism (CDM) established by the Kyoto Protocol, and sell carbon credits on the regulated market. On the other hand, there are the voluntary markets in which private or public organizations including developed and developing or VERs can buy voluntary carbon credits. These emission reductions are verified by independent standards highlighting the VCS (Voluntary Carbon Standard) and the Gold Standard, which possess widely recognized methodologies. Forestry projects where the main target is the timber, unlike those proposed for pulp, have the advantage of carbon is accumulated over time as once cut the trees, much of it remains in durables (furniture, houses, in another.).

The volume of carbon sequestered evolves with wooden stock in forest and in the case of Chihuahua Woods presents an estimate of your progress in the following table 1 (only considered the Eucalyptus grandis):

For reference we mention that the prices of emission reduction certificates from forestry projects reached higher values at 5 Euros for their contribution as significantly influence on the cash flow of the project (expected price considered is 3.5 Euros). In addition obtaining Certificates Carbon is a social recognition impact positive project towards sustainable development of the region where it is realized improvements generating social, economic and environmental.

<table>
<thead>
<tr>
<th>Years</th>
<th>Hectares raised</th>
<th>Accumulated tons of carbon sequestered</th>
<th>Certificates Issued in Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>-</td>
<td>-</td>
<td>142903</td>
</tr>
<tr>
<td>2011</td>
<td>1200</td>
<td>-</td>
<td>142903</td>
</tr>
<tr>
<td>2012</td>
<td>1500</td>
<td>9391</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>1320</td>
<td>48341</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td></td>
<td>106430</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td></td>
<td>187830</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td>285807</td>
<td>327007</td>
</tr>
<tr>
<td>2017</td>
<td></td>
<td>417382</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td></td>
<td>562849</td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td></td>
<td>717737</td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td></td>
<td>878424</td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td></td>
<td>939821</td>
<td>327007</td>
</tr>
<tr>
<td>2022</td>
<td></td>
<td>967304</td>
<td></td>
</tr>
<tr>
<td>2023</td>
<td></td>
<td>999150</td>
<td></td>
</tr>
<tr>
<td>2024</td>
<td></td>
<td>1133366</td>
<td></td>
</tr>
<tr>
<td>2025</td>
<td></td>
<td>1267551</td>
<td></td>
</tr>
<tr>
<td>2026</td>
<td></td>
<td>1334022</td>
<td>197100</td>
</tr>
<tr>
<td>2027</td>
<td></td>
<td>1379512</td>
<td></td>
</tr>
<tr>
<td>2028</td>
<td></td>
<td>1429443</td>
<td></td>
</tr>
<tr>
<td>2029</td>
<td></td>
<td>1547466</td>
<td>106722</td>
</tr>
<tr>
<td>2030</td>
<td></td>
<td>1131682</td>
<td></td>
</tr>
<tr>
<td>2031</td>
<td></td>
<td>547536</td>
<td></td>
</tr>
</tbody>
</table>

IV. DESIGN OF EXPERIMENTS ASSOCIATED WITH THE RISK ANALYSIS

In order to obtain the most efficient arrangement of issues by species, we developed a cluster for storing the data of each representative individual for each species. The narrative guide is made with the purpose of distributing an optimal form for each evaluated species as in [6].

Project income came from the following sources:

- Sale of wood.
- Sale of land.
- Beta carbon certificates.
- Grazing.

Accounting records the growth of forests according to the International Accounting Standard No. 41 Agriculture. The planned timber sales arising from the following activities:

- **Planting Eucalyptus dunnii:**
  - Destination: pulpwood.
  - 2680 hectares planted.
  - Two shifts planting (year 9 and 18)

- **Planting Eucalyptus Grandis:**
  - Target: 49% pulpwood and 51% for sawing wood.
  - 4020 has. planted
  - Two thinning (year 9 and 14)
  - Harvest in year 18

It was a field use 67% of the total acres acquired (10,000 has.9, of which 40% is planted with dunnii and 60% or Grandis which was determining with our Bioinspired Algorithm shown the result in Figure 2 which detail a map with different regions associated with specific weathers and conditionals of habitats.

We have taken the following base prices (put on floor):

- **Dunii – Pulpwood US$/m³** 45
- **Grandis**
  - Pulpwood US$/m³ 45
  - Sawing US/m3 90
- **Pasturage – US$** 9 per total hectare.

It was considered a real annual growth of 1.5% over the base price of the wood. The land price was set at U.S. $2,700 per hectare, with $90 of expenses and a real growth rate of 3%.

**Identifying risk variables.**

Were defined as sensitive variables for the model include diverse variables as is shown in Table 2:

<table>
<thead>
<tr>
<th>Categories</th>
<th>Variable</th>
<th>Unit</th>
<th>Expected scenario</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth</td>
<td>IMA E. grandis</td>
<td>m³/ha</td>
<td>24</td>
<td>20</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>IMA E. dunnii</td>
<td>m³/ha</td>
<td>22</td>
<td>18</td>
<td>28</td>
</tr>
<tr>
<td>Use</td>
<td>Plantation E. grandis</td>
<td>Area %</td>
<td>60</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Plantation E. dunnii</td>
<td>Area %</td>
<td>67</td>
<td>60</td>
<td>70</td>
</tr>
</tbody>
</table>

Figure 2. Map resultant with the interaction of our Bioinspired Algorithm determining the potential of each region and the future potential in green.

The main experiment consisted in implementing and represent the species as a group of 100 bats (size of the population) in the proposal Bat Algorithm, and with loudness $A$, pulse emission rate $r$, $e$, $a$ and $y$ values to represent to the two species improve the potential of the project. The stop condition is reached after 50 iterations with a final map implemented to visualization; this allowed generating the best selection of each kind and their possible location in the future in a specific Model as in Figure 3.
policies to the people in the region, considering what Mexico will be the fifth economical potency to this data.

V. CONCLUSIONS

After our experiments we were able to remark the importance of the diversity of the established economical patterns for each forestalls specie. These patterns represent a unique form of adaptive behavior that solves a computational problem that does not make clusters of these species. The resultant configurations can be metaphorically related to the knowledge of the behavior of the community with respect to an optimization problem because the forest industry is the most important in 27 municipalities. Our implementation related with each species and its economical potential to a specific location. The interactive map build allowed us to identify changes in time related to each species. Here, we show that the use of Bat Algorithm substantially increased the understanding in obtaining the "best financial trust forest". This after the composition of a structural bats representation was made based on the problem that keeps their attributes. Therefore, we realize that the concept of "temporality optimization" exists based on determining the acceptance function to propose diversify the products in the time. For further implementations we intend to analyze the level and degree of cognitive knowledge for each species. Additionally, this may help to understand true similarities that share different species based in the characteristics to be clustered and also to keep their own biological identity. In a related work, it has been demonstrated that small variations go beyond phenotypic characteristics and are mainly associate to tastes and related characteristics developed through the time. On the other hand, Bat Algorithm can be used in the Evolutionary Robotic field where social interaction and decision is needed, for example in the training phase described in [7], and to organize group of robots for collaborative tasks. In a future research we try to understand the impact of footprint in this society by this reason our research focus in a “Support System for Decision Making to determine the ecological footprint using Scout Bee Algorithm” published in Euskera language in Basque Country during this year in a internship occurred in Deusto University.

ACKNOWLEDGMENT

The work is partially supported by CIS Research at Juarez City University.

REFERENCES