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RILSIM: A Financial Simulation Modelling System for Reduced-Impact Logging

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Summary

RILSIM is a computer software package designed to permit users to rapidly estimate the cost and net revenue associated with logging operations so that they can compare short-term financial costs and returns expected from reduced-impact logging with those expected from conventional logging under identical local site conditions. The purpose of the software is to help users learn about reduced-impact logging and its potential financial advantages as compared to conventional logging. The focus of efforts to introduce RILSIM is on users in tropical countries where logging impacts are widely considered to be incompatible with sustainable forest management.

***Keywords**: Reduced-impact logging, harvesting, software, financial analysis*

Introduction

This paper introduces RILSIM (Reduced Impact Logging SIMulator), a discrete-event, deterministic computer simulation modelling system designed to permit users to rapidly compare the cost of reduced-impact logging (RIL) against the cost of conventional logging (CL) under identical local site conditions.

Over the past decade or so, considerable interest has developed in the application of reduced-impact logging, especially in tropical forests where damage associated with logging has often been regarded as inconsistent with sustainable forest management (Marn and Jonkers 1982, Estève 1983, Sist *et al.* 1998). RIL comprises a set of harvesting technologies that have been proven to reduce impacts to residual vegetation, soils, and other environmental attributes as compared to "conventional" logging technologies.

Conventional logging as widely practiced in tropical forests is characterized by little or no advance planning, the use of poorly trained personnel operating with improper equipment and tools, and minimal oversight by supervisory

personnel and government agents. This often results in very high rates of soil disturbance and damage to residual vegetation, with skidtrails covering up to 80% of the ground surface, streams dammed up by roads built without drainage structures, and 60% or more of immature trees damaged or killed.

There is no fixed definition of what constitutes RIL because the specific procedures and types of equipment vary with local conditions. Nevertheless a RIL operation in tropical forest typically includes the following (Dykstra and Heinrich 1996, FAO 1999, Dykstra 2002):

- Pre-harvest inventory and mapping of individual crop trees.
- Pre-harvest planning of roads, skidtrails, and landings to provide access to the harvest area and to the individual trees scheduled for harvest while minimizing soil disturbance and protecting streams and waterways with appropriate crossings.
- Cutting of vines prior to harvest in areas where large woody vines tend to form webs that connect tree crowns.
- The use of controlled felling and bucking techniques, including directional felling, cutting stumps low to the ground to avoid waste, and optimal crosscutting of tree stems into logs to maximize recovery.
- Construction of roads, landings, and skidtrails so that they adhere to engineering and environmental design guidelines.
- Winching logs to planned skidtrails and ensuring that skidding machines remain on the skidtrails at all times.
- Where feasible, utilizing yarding systems that protect soils and residual vegetation by suspending logs above the ground.
- Conducting post-harvest assessments to provide feedback to the timber concession holder and the logging crews, and to evaluate the degree to which RIL guidelines were applied successfully.

Most of these practices have been developed for temperate forests and are commonly used in industrialized countries, either because they are required by government regulation or because forest managers recognize that such practices save money in the short term and also maximize the value of the forest in the longer term. RIL practices are also being adopted in some tropical countries, although resistance to change remains high (FAO 2001). A common explanation for resistance to RIL technologies in tropical countries is the belief by logging operators and forest managers that these technologies will increase logging costs and thus reduce short-term profits.

A number of studies carried out over the past two decades have demonstrated that RIL can often reduce total logging cost by comparison with conventional logging, even when the longer-term economic effects of improved post-harvest forest condition and reduced environmental impacts are ignored (Marn and Jonkers 1982, Hendrison 1989, van der Hout 1999, Holmes *et al.* 2000). These results are often viewed with suspicion by loggers in developing countries, however, because the conditions described in the studies seem too different from what the loggers encounter on a daily basis.

As a way of overcoming resistance to the adoption of RIL, participants in recent conferences on reduced-impact logging (see, for example, Enters and Durst 2002) have called for development of simple technologies that could help loggers and forest managers plan their operations and estimate costs and revenues so that they can evaluate expected financial and organizational differences between RIL and conventional logging. The RILSIM software described in this paper is one response to this call.

Development of RILSIM

In 2000, at the initiative of the University of Florida, CIFOR, and the USDA Forest Service, a steering committee[1] was formed to consider the idea of developing software to simplify financial analyses of logging systems. As a result of several planning meetings and a hands-on workshop involving potential users of the software from throughout Southeast Asia, the following **design criteria** were established by the steering committee:

- The software should be compatible with any 32-bit Microsoft® Windows® operating system (*i.e.,* Windows 95 or later).
- Hardware requirements for operating the software should be relatively modest in order to accommodate users in developing countries. The software should occupy less than 20 Mbytes of space on the hard disk and should run on a Windows 95 system with only 32 Mbytes of random-access memory and a Pentium-class processor operating at 75 MHz.
- The modelling package should include a comprehensive, easy-to-use help system and a printed User's Guide.
- The software should be provided at no cost except for a small distribution charge to cover the cost of the CD-ROM and printed User's Guide.
- The modelling system should be a stand-alone package; no additional software other than the operating system should be required. However, it should be compatible with software such as spreadsheets, where the capabilities of those programs can be used to advantage.
- The software should be simple to use and understand for people with little computer experience.
- Aside from its computational abilities, the software should be designed as a learning tool to help users learn about RIL and about financial analysis.
- It should be possible for users to express the financial results in any currency.

[1] Members of the RILSIM Steering Committee included **Alex Moad** and **Gary Man** (USDA Forest Service), **Grahame Applegate** and **Laura Snook** (CIFOR), and **Francis E. Putz** (University of Florida). **Dennis Dykstra** (Blue Ox Forestry) joined the steering committee in 2001. Additional resource people who attended one or more steering committee meetings included **John Tay** (Innoprise Corporation, Sabah, Malaysia), **Johan Zweede** (Tropical Forest Foundation, Belém, Brazil), **Tom Holmes** (USDA Forest Service), and **Fred Boltz** (University of Florida).

- The source code should be available to permit modifications such as translation into languages other than English.

These criteria had a major influence on the way RILSIM was eventually developed. Ideas that were considered included the development of a set of spreadsheet templates and macros, or the use of a commercial modelling package such as STELLA, a system dynamics simulator. Disadvantages of these alternatives included difficulties in representing various types of precedence relationships that are inherent in logging operations and the fact that both alternatives would require users to purchase (and learn to use) additional software. A license to use STELLA, for instance, costs more than $1000—a large investment for much of the target audience (loggers, forest managers, and NGOs in developing countries)—and the modelling language itself, based on differential equations, might also prove difficult for many in this audience. The possibility of developing a modelling system with spreadsheet templates and macros was perceived as more justifiable, simply because it seemed likely that many users would already be familiar with spreadsheet software. However, tests with several trial versions showed that a spreadsheet capable of analyzing a large-scale logging operation could easily overwhelm the capabilities of the minimum hardware system identified in the list of design criteria.

As a result of the steering committee's work it was decided that RILSIM should be developed as a stand-alone computer software package. C++ was selected as the development language. Actual development was done with Microsoft® Visual C++® 6.0 using the Microsoft Foundation Classes for Windows. The development system was a 733-MHz, Pentium III computer with Windows XP Professional, and the software was also tested at each stage of development under Windows 95, Windows 98/Me, and Windows 2000. The Windows 95 test computer was configured as the minimum hardware system identified in the list of design criteria.

A preliminary version of the software was produced by April 2002 and used as the basis for a workshop held at CIFOR headquarters in Bogor, Indonesia in May of that year. Participants in the workshop included representatives of the private sector, government forestry agencies, universities, research institutions, and NGOs from throughout Southeast Asia. As a result of suggestions made by the participants, many changes were made to the user interface and new capabilities were added. The initial release version of the software was finalized in March 2003.

The RILSIM Approach

The general approach used in a financial analysis with RILSIM is as follows:

- Data entry is achieved through a series of "data forms" designed to lead users in a natural way through the process of developing the information needed to do a financial analysis. The different data forms are accessed through a tabbed interface in the main RILSIM window (Figure 1).
- The data forms are used to describe local conditions and set simulation options, quantify wages or other methods of worker compensation (*e.g.,* piece rates), specify equipment costs (which may be entered as hourly costs or as piece rates), define logging and support activities, and enter other information relevant to the analysis. Figure 1 shows one of the data forms with both user-entered data and also information calculated by RILSIM.

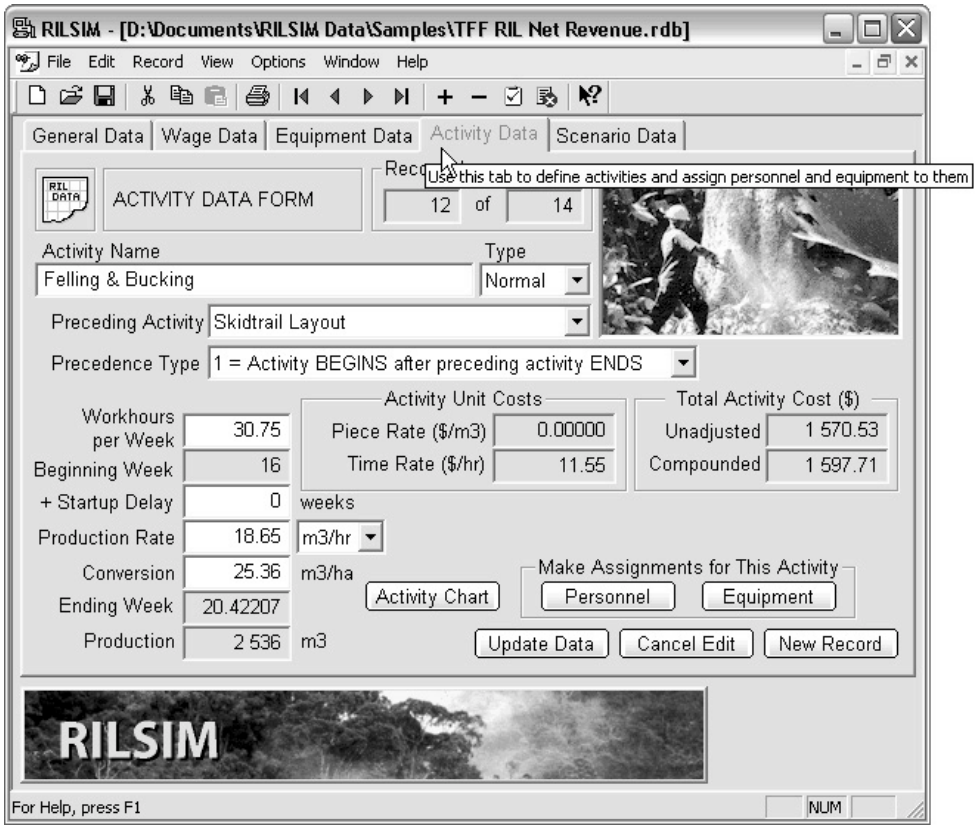

Figure 1.
The RILSIM user interface consists of a set of tabbed data forms to help users describe the local conditions, costs, revenues, production rates, sequence of activities, and other data needed to analyze a specific logging operation. As shown above, when the user's mouse cursor hovers over a tab (near the top of the form), a small popup window gives a brief explanation of that tab's purpose. The Activity Data Form shown here has been filled out for an activity named "Felling & Bucking", which is scheduled to begin after a preceding activity named "Skidtrail Layout" has ended. White boxes on the form are filled in by the user, whereas gray boxes contain results computed by RILSIM. Buttons (white rectangles with rounded corners and slight shading to give a rounded appearance) are used to open other forms or to execute commands. The menu and toolbar above the data form can also be used to execute commands. Standard Windows nomenclature and icons are used. Although this form shows costs denominated in dollars, users can specify any currency they wish. The decimal point can be designated either as a full stop, as shown here, or as a comma.

- To help users visualize relationships among activities and revise them in an intuitive way, an "activity network diagram" can be created by clicking the Activity Chart button (Figure 1). An example of such a network diagram is shown in Figure 2. An activity can be moved in the diagram in order to change the sequence of activities in the logging operation. The network diagram can also be used to edit activity names and to add or delete activities, or even to prune part of the sequence by deleting an activity and all of its subsidiary activities. When the user is satisfied, the diagram can be printed as part of the documentation for the analysis.

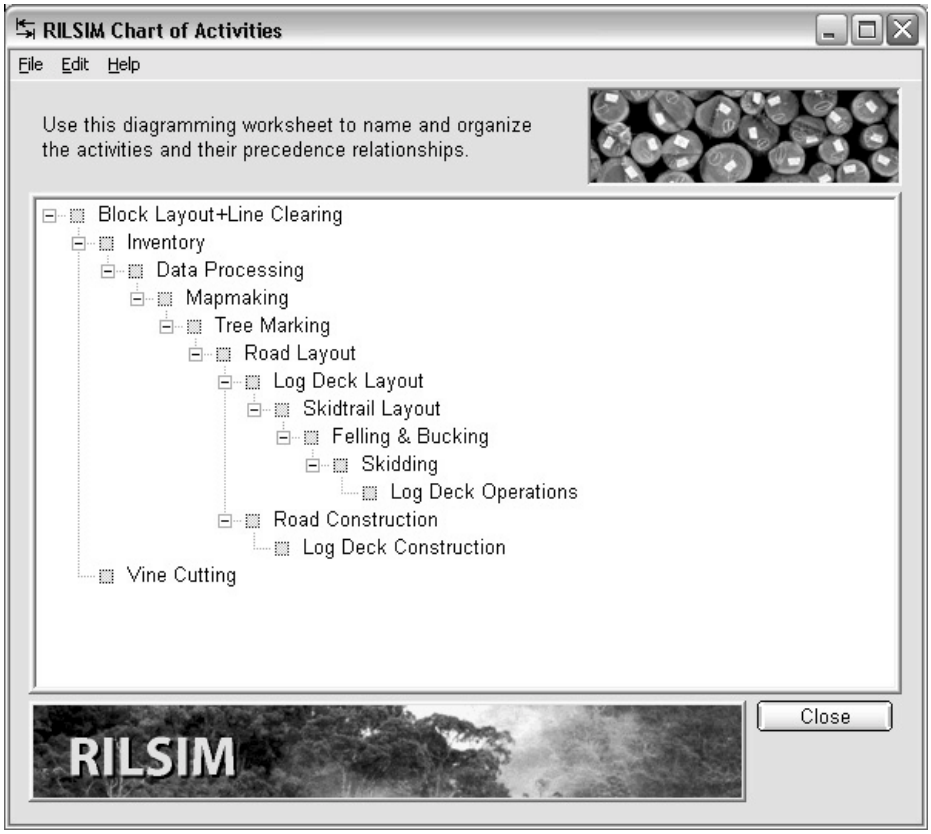

Figure 2.
An activity network diagram for a RILSIM analysis. Activities can be renamed, deleted, added, or moved to new positions directly on the network diagram. Changes are reflected immediately in the RILSIM database for the problem.

- After the data for an analysis have been entered, the user opens the Scenario Data form, enters a description of the scenario, possibly selects among several options, and then clicks a "Run Scenario" button. This causes the simulation engine to step through the operation activity by activity, computing beginning and ending times for each activity and, based on these times, calculating the activity cost. The cost is then discounted or compounded using an interest rate and a reference time for interest calculations that can be specified by the user. Net revenues may also be calculated if this option has been selected by the user. A full simulation run typically requires only a fraction of a second.
- When a scenario analysis has been run, the user can print a report to summarize the results (Figure 3). Another report, listing just the activities with their scheduled beginning and ending times and associated costs as calculated by RILSIM, can saved in a format that allows it to be read into spreadsheet programs such as Microsoft Excel, permitting comparative charts to be prepared as shown in Figure 4. The current version of RILSIM does not produce such charts directly, although this feature could be added in a future version.

- Besides permitting rapid estimation of logging costs, RILSIM has also been designed as a teaching tool, with a comprehensive "context sensitive" help system that guides users through each stage of data entry and analysis. A printed User's Guide is also provided in the distribution package.

RILSIM Distribution

An initial distribution package including a CD-ROM and a printed User's Guide is being distributed free of charge through RILNET, an online service dedicated to providing information about reduced-impact logging. RILNET[2] is operated through the FAO Regional Office for Asia and the Pacific in Bangkok with support from the USDA Forest Service. The software with an electronic version of the User's Guide will also be distributed as a free Internet download from the website of the Asia-Pacific Forestry Commission at http://www. apfcweb.org/ and from the Blue Ox Forestry website at http://www.blueoxforestry.com/.

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[2] For information about RILNET, email inquiries may be sent to tlc@loxinfo.co.th.

RILSIM Simulation Report

Section 1. Overall Summary

Project Description ..... Tropical Forest Foundation RIL Study, Eastern Amazonia (2000)
Organization ..... The RILSIM Project
Analyst ..... Dennis P. Dykstra
Scenario ..... Reduced-Impact Logging
Logging Area ..... 100 ha
Difficulty Index 1.0
Annual Interest Rate 27.4%
Interest Compounded ..... Monthly
Reference Time for Discounting and Compounding:
Beginning of ..... Activity 14, Log Deck Operations
Simulation Time Unit ..... 1 week
Comparison Basis ..... Net Revenue from Log Production
Log Price ..... 30.00 $/m3
Currency ..... US dollars ($)

Section 2. Activity Report

Note: Costs in the "Adjusted" column have been compounded or discounted to the reference time indicated in Section 1 to account for the time value of money at the specified interest rate and compounding frequency.

Activity Number and Name	Time Period (weeks) Begin	End	Cost ($) Unadjusted	Cost ($) Adjusted
1 Block Layout & Line Clearing	0.000	2.401	564.97	628.00
2 Inventory	3.000	5.101	1 076.72	1 179.20
3 Vine Cutting	3.000	5.101	300.38	328.97
4 Data Processing	6.000	6.457	239.56	259.40
5 Mapmaking	7.000	8.264	473.74	509.23
6 Tree Marking	9.000	10.017	322.31	343.09
7 Road Layout	11.000	11.182	56.49	59.64
8 Log Deck Layout	12.000	12.106	32.93	34.59
9 Road Construction	12.000	12.200	363.22	381.45
10 Log Deck Construction	13.000	13.200	363.23	379.46
11 Skidtrail Layout	13.000	15.132	682.60	709.56
12 Felling & Bucking	16.000	20.422	1 570.53	1 597.71
13 Skidding	21.000	23.003	3 138.47	3 130.30
14 Log Deck Operations	22.000	24.003	3 240.84	3 215.60
Total Simulation Operating Time (weeks)	24.0025268478			
Total Cost and Total Compounded Cost ($)			12 425.97	12 756.19
Net Revenue and Discounted Net Revenue ($)			63 654.03	62 731.32

Figure 3.
A sample simulation report produced by RILSIM. Using standard Windows dialogs, users can select the page size and choose printing options such as portrait or landscape page orientation. For multi-page reports the page range to be printed can also be specified.

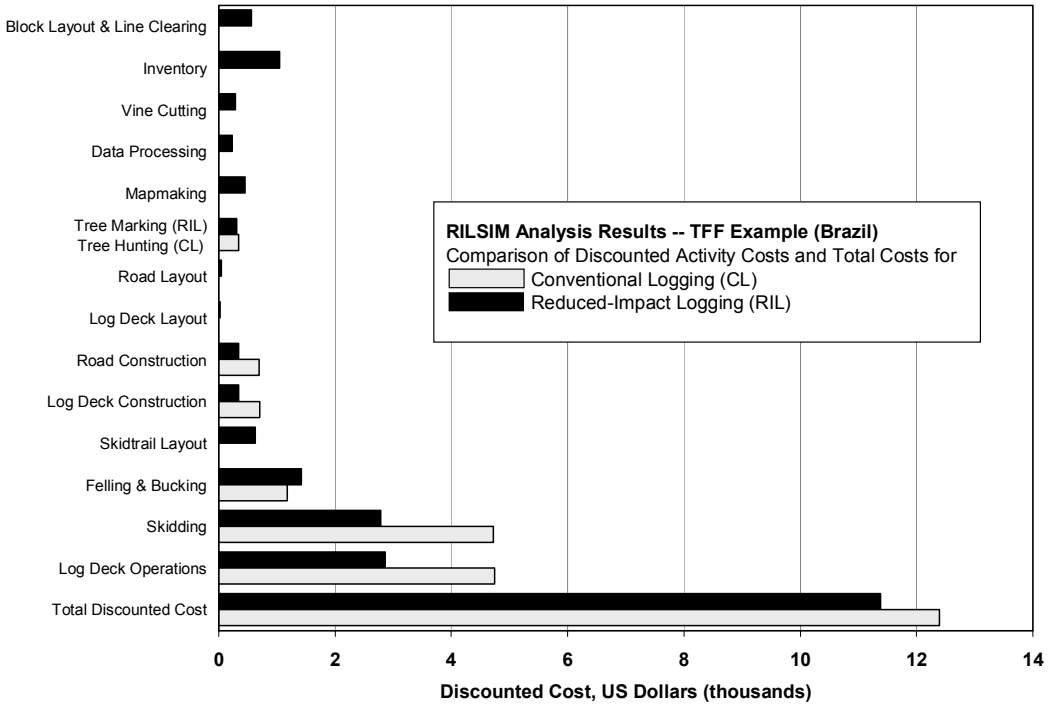

Figure 4.
Chart comparing costs of conventional logging and reduced-impact logging. The chart was produced with Microsoft Excel using RILSIM results from two scenario runs, one for each type of logging. Data were taken from Holmes et al. (2000).

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