Sub-Saharan Africa Transport Policy Program

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User Guide

Version 2.0 - January 2009

Rodrigo Archondo-Callao

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Road Network Evaluation Tools (RONET)

Version 2.0

User's Guide

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January 2009

The SSATP is an international partnership to facilitate policy development and related capacity building in the transport sector in Sub-Saharan Africa.

Sound policies lead to safe, reliable and cost-effective transport, freeing people to lift themselves out of poverty, and helping countries to compete internationally.

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Preface

The Road Network Evaluation Tools (RONET) is a model which could be used by decision makers to appreciate the current state of the road network, its relative importance to the economy (e.g. asset value as percentage of GDP) and to compute a set of monitoring indicators to assess the performance of the road network.

RONET assess the performance over time of the road network under different road maintenance standards. It determines, for example, the minimum cost for sustaining the network in its current condition and estimates the savings or the costs to the economy for maintaining the network at different levels of service. RONET determines the allocation of expenditures among recurrent maintenance, periodic maintenance, and rehabilitation road works.

This version of RONET determines the optimal maintenance standard for each road class (highest Net Present Value) and compares it with the current (budget constraint) and other maintenance standards. Finally it determines the "funding gap," defined as the difference between current maintenance spending and required maintenance spending (to maintain the network at a given level of service), and the effect of under spending on increased transport costs.

The new Road User Revenues Module, estimates the level of road user charges required (e.g. fuel levy) to meet road maintenance expenditures under different budget scenarios. This could be used by road fund boards to prepare a business case to negotiate and revise road tariffs on a sound basis.

RONET is developed from the same principles underlying the Highway Development and Management Model (HDM-4). RONET uses simplified road user costs relationships, based on HDM-4 or other relationships, and simplifies the road deterioration equations derived from the HDM-4 research. Thus, RONET is a user friendly model which requires less data and less technical capacity to run than HDM-4.

The primary audience of RONET is decision makers in the road sector, for whom it is designed as a tool to advocate for continuous support for the road maintenance initiative.

Mustapha Benmaamar, Sr. Transport Specialist, SSATP

Acknowledgments

The development of the RONET model is being funded by the Sub-Saharan Africa Transport Policy Program (SSATP), which is a collaborative framework set up to improve transport policies and strengthen institutional capacity in the Africa region. The model was developed by Rodrigo Archondo-Callao, Senior Highway Engineer, The World Bank, under the management of Olav E. Ellevset, Sr. Transport Specialist, SSATP, and Mustapha Benmaamar, Sr. Transport Specialist, SSATP. The model development is benefiting from contributions of a peer advisory group composed of David Luyimbazi (Uganda), Godwin Brocke (Ghana), Atanásio Mugunhe (Mozambique), Joseph Lwiza (Tanzania), Torben Larsen (Denmark), Eliamin Tenga (Tanzania), and Alberto Nogales (Bolivia).

List of Acronyms and Abbreviations

AADT	Average Annual Daily Traffic
ANE	National Roads Administration in Mozambique
ESA	Equivalent Standard Axles
ETWTR	Energy, Transport & Water Department's Transport Unit (The World Bank)
GDP	Gross Domestic Product
HDM	Highway Development & Management
HNMS	Highway Network Management System (Mozambique)
IQL	Information Quality Level
IRI	International Roughness Index
Km	Kilometer
PAM	Performance Assessment Model
PMORALG	Prime Ministers Office Regional Administration and Local Government
PMS	Pavement Management System
RAFU	Road Agency Formation Unit
RAI	Rural Access Indicator
RED	Road Economic Decision Model
RMI	Road Management Initiative
RMMS	Road Maintenance Management System (Tanzania)
ROCKS	Road Cost Knowledge System
RONET	Road Network Evaluation Tools
RSSS	Road Sector Strategy Study (Mozambique)
RUC	Road User Charges Model
RUCKS	Road User Costs Knowledge System
SAM	Social Accounting Matrix
SSATP	Sub-Saharan Africa Transport Policy Program
ST	Surface Treatment
TANROADS	Tanzania National Roads Agency
TTC	Total Transport Costs
UNRA	Uganda National Roads Authority
USD	United States Dollar
VOC	Vehicle operating cost

Part A – Overview

INTRODUCTION

The Road Network Evaluation Tools (RONET) model is being developed for the Sub-Saharan Africa Transport Policy Program[1] (SSATP) by the Energy, Transport and Water Department, Transport Anchor (ETWTR), of the World Bank to assist decision makers to accomplish the following:

- Monitor the current condition of the road network
- Plan allocation of resources
- Assess the consequences of macro-policies on the road network
- Evaluate road user charges revenues

RONET is a tool for assessing the performance of road maintenance and rehabilitation policies and the importance of the road sector to the economy. This in turn demonstrates to stakeholders the importance of continued support for road maintenance initiatives. It assesses the current network condition and traffic, computes the asset value of the network and road network monitoring indicators. It uses country-specific relationships between maintenance spending and road condition, and between road condition and road user costs, to assess the performance over time of the network under different road works standards. It determines, for example, the minimum cost for sustaining the network in its current condition. It also estimates the savings or the costs to the economy to be obtained from maintaining the network at different levels of road condition. It further determines the proper allocation of expenditures among recurrent maintenance, periodic maintenance, and rehabilitation road works. Finally it determines the "funding gap," defined as the difference between current maintenance spending and required maintenance spending (to maintain the network at a given level of road condition), and the effect of under spending on increased transport costs.

The model is developed from the same principles underlying the accepted economic evaluation model Highway Development and Management Model[2] (HDM-4), adopting simplified road user costs relationships and simplified road deterioration equations derived from the HDM-4 research. HDM-4 is an economic evaluation module of a Pavement Management System that can perform a strategic evaluation of a network, evaluating a series of road classes similar to what is being done in RONET. HDM-4 has comprehensive road deterioration and road user cost relationships, has great flexibility on the way of defining the maintenance, rehabilitation or improvement standards to be evaluated, and performs a budget constraint optimization. The characteristic of HDM-4 is that it has many input data requirements, requires an HDM-4 specialist to run the model, and its output are limited and require external manipulation. For example, very few of the RONET outputs are given by HDM-4 automatically, but most of the RONET outputs can be obtained from an HDM-4 run after processing the HDM-4 inputs and outputs in Excel or Access. The characteristic of RONET is the use of simplified road deterioration and road user costs relationships, the restricted way defining the standards, the

inability to evaluate improvement standards, and the lack of a budget constraints optimization module.

The primary audience for RONET is decision makers in the road sector, for whom it is designed as a tool for advocacy of specific revenue enhancing or cost recovery measures. This new version of RONET provides an interface between road maintenance expenditures and needs with the funding requirements through road user charges. This could be used by road fund boards to develop a business case to negotiate and revise road tariffs on a sound basis.

RONET is being developed for use in the Africa region, but there are no impediments to its application in any other country worldwide. RONET includes a series of analytical tools designed to evaluate the road network and road sector of a country at a macro-level by evaluating a series of representative road classes, which can be characterized, for example, as (i) functional classification, (ii) surface type, (iii) traffic level, (iv) road condition, (v) terrain, (vi) climate, and (vii) geographical region.

In the past SSATP has developed two other software tools, also designed to evaluate an entire road network by evaluating a series of representative road classes, as follows:

- The Road User Charges Model Version 3.0[3] (RUC), which evaluates scenarios of road user charges in a country, evaluating road classes in good and fair condition differentiated by traffic level, and estimates routine and periodic maintenance requirements derived from look-up solution tables. The RUC model represents the entire network of a country by a maximum of 160 road classes that are functions of traffic, percent of cars, trucks loading, pavement strength, environment, level of agency costs, and vehicle operating costs.
- The Performance Assessment Model Version 1.0[4] (PAM), which estimates the performance of a road network under different budget scenarios, evaluating road classes on any road condition but not differentiating the road classes by traffic level, and estimates routine and periodic maintenance requirements derived from a straight line deterioration model. The PAM model represents the entire network of a country by a maximum of 64 road classes that are functions of functional classification, pavement type, and condition.

RONET is being developed to replace the functionality of the RUC and PAM models and to add new evaluation modules and output reports. RONET is being developed in a modular form, characterizes the entire road network of a country by allowing the definition of a maximum of 625 road classes, and includes simplified road deterioration models based on HDM-4 research. RONET version 2.0 implements the following evaluation modules:

- *Current Condition Assessment* that calculates current road network statistics and network monitoring indicators
- *Performance* Assessment that evaluates the road network performance under different rehabilitation and maintenance budget scenarios and presents the consequences to the road agency, the road user, and the road infrastructure
- *Road User Revenues* that evaluates revenues being collected from road user charges and compares them with the funding requirements

The main improvements of version 2.0 are the following:

- New module to evaluate road user revenues was added
- Current Condition Assessment Module now computes network safety indicators
- Performance Assessment Module was redesigned to compare either (i) budget scenarios, (ii) maintenance and rehabilitation standards scenarios, or (iii) custom standard scenarios
- Performance Assessment Module now computes the optimal standard per road class (highest Net Present Value) representing the optimal budget scenario
- Performance Assessment Module has now new output reports presenting, for example, the annual work program, solution catalog and affordability indicators for a given budget scenario
- Custom budget scenario is now user defined by selecting one maintenance standard per network type and traffic level
- RONET is now calculating the road works costs per Vehicle-Km ($/veh-km) for a given budget scenario
- The default network types are now Motorways, Primary, Secondary, Tertiary and Unclassified

MODEL STRUCTURE

To run RONET you first review the Configuration pages and modify any configuration data, if necessary. Cells with a bright yellow background indicate country-specific inputs that you are expected to modify, whereas cells with dim yellow backgrounds indicate user-defined RONET defaults that most likely you will not need to modify. Then you enter the country-specific inputs at the following Input Data pages:

- *Country Data* that collects land area, total population, rural population, gross domestic product at current prices, total Country road network, diesel and gasoline fuel consumption, total vehicle fleet, discount rate, traffic growth rates, pavement widths, capital works unit costs, recurrent maintenance works unit costs, traffic level characteristics, vehicle fleet unit road user costs relationship to roughness, and accidents rates and costs
- *Road Network Length* that collects the road network length distribution by road classes that are functions of network type, surface type, traffic category and condition category
- *Historical Expenditures* that collects historical average road expenditures and road works during the last five years per surface class and road work type
- *Road User Charges* that collects current road user charges assigned to a road fund, main road agency, other road sector, and general budget
- *Funding Requirements* that collects the funding requirements for recurrent maintenance, periodic maintenance, rehabilitation, administration, and investment expenditures to be cover by road user charges

The RONET road network length can cover the entire road network system of the country (roads, highways, expressways, streets, avenues, and so forth), or a partial road network; for example, the road network of a state or province of the country, or the road network managed by the main road agency. The road network is represented by road classes that are a function of (i) five network types, (ii) five surface types, (iii) five traffic categories, and (iv) five condition categories, which total a maximum of 625 road classes. Table 1 illustrates the representative road classes.

Table 1. Matrix of Road Classes: Overall Network Evaluation

Matrix of Road Classes: Overall Network Evaluation					
Network Type	**Surface Type**				
	Concrete	Asphalt	S.T.	Gravel	Earth
Motorways					
Primary					
Secondary					
Tertiary					
Unclassified					

Traffic Category	**Condition Category**				
	Very Good	Good	Fair	Poor	Very Poor
Traffic I					
Traffic II					
Traffic III					
Traffic IV					
Traffic V					

Network Types

The road network is subdivided into as many as five network types that are user defined. The default configuration subdivides the network into five network types characterized by functional classification, but with the option to change the default configuration and redefine the characteristics of each road network type. For example, each network type can represent a different, region, terrain type, or climate type. Table 2 below shows the default configuration and sample user-defined configurations.

Table 2. Default Configuration and Alternative Configurations

	Default Configuration	Alternative Configurations Examples	
Network Type	Types by Functional Class	Types by Geographic Region	Types by Terrain Type
1	Motorways	North Region	Flat Terrain
2	Primary	South Region	Hilly Terrain
3	Secondary	Easthern Region	Mountainous Terrain
4	Tertiary	Western Region	NA
5	Unclassified	Central Region	NA

The default RONET road network types are based on the functional classification of the roads. The default network types are as follows:

- *Motorways:* Roads specially designed and built for motor traffic, which does not serve properties bordering on the roads, with four lanes or more lanes, separate carriageways for the two directions of traffic, and with access control.

- *Primary:* Arterial, main, trunk, or national roads, which are roads outside urban areas that belong to the top-level road network and generally, have higher design standards than other roads. These roads generally provide the highest level of mobility, at the highest speed, for long interrupted traffic. These roads form the principal avenue of communication between and through major regions of the country, between regional capitals and key towns that have significant national economic and social interaction, and between the country and adjoining countries, whose main function is to provide access to freight terminals, including ports.
- *Secondary*: Collectors, classified as rural or regional roads, which are the main feeder routes into primary roads, and provide the main links between primary roads. These roads generally provide a lower degree of mobility than primary roads, being designed for travel at lower speeds and for shorter distances. These roads form the principal avenue of communication between primary roads and key towns and between primary roads and important centers, which have a significant economic, social tourist, or recreation role (for example, tourism and resource development).
- *Tertiary:* Local roads, which are classified as rural or local roads. The roads are characterized by a comparatively low-level design standard and traffic. These roads provide basic access between residential and commercial properties, connecting with higher-order roads. The function of these roads is to provide the only access to scattered rural settlements and primarily serve local social services, as well as provide access to markets and generally form the first phase of the journey for commuters.
- *Unclassified:* Unclassified roads, which are roads that do not fall into any of the previous categories. These roads comprise special-purpose public roads that cannot be assigned to any other class above, and which are provided almost exclusively for one specific activity or function, such as recreational, forestry, mining, national parks, or dam access.

On different countries, different road networks are managed by different road agencies or entities; therefore, RONET allows for definition of the management responsibility type of each road network. On the RONET Basic Configuration page, you assign one possible management type or entity (management and funding responsibility) to each road network type. The default user-defined management types are the following:

- *Private* sector: roads that are under the jurisdiction of concessionaires
- *National* road agency: roads that are under the jurisdiction of the national road agency
- *Regional* road agencies: roads that are under the jurisdiction of regional, provincial, or state governments
- *Local* road agencies: roads under the jurisdiction of district or local governments
- *Urban* municipalities: roads, streets and avenues that are under the jurisdiction of city or town governments.

Surface Types

Each network type is subdivided into the following five possible surface types:

- Cement concrete pavement
- Asphalt mix pavement

- Surface treatment pavement
- Gravel road
- Earth road

The characteristics of each surface type are defined on the Basic Configuration page.

Traffic Categories

Each surface type is subdivided into five possible traffic categories (Traffic I, Traffic II, Traffic III, Traffic IV, Traffic V). To each traffic category, you assign one of nine possible traffic levels (T1 to T9) defined on the RONET Basic Configuration page. Table 3 presents the default nine RONET traffic levels, based on a logarithmic scale. The table presents the traffic characteristics of each traffic level and corresponding illustrative geometric and pavement standards. Proper geometric and pavement standards are country-specific and are the product of an economic evaluation; therefore, the standards presented in table 3 are given only for illustrative purposes.

Table 3. RONET Default Traffic Levels

	Average Annual Daily Traffic (AADT)			Illustrative Standards	
Traffic Level	Minimum (veh/day)	Maximum (veh/day)	Average (veh/day)	Geometry Standard	Pavement Standard
T1	0	10	5	1-lane warranted	Formation not warranted
T2	10	30	20	1-lane warranted	Formation warranted
T3	30	100	65	2-lane warranted	Gravel warranted
T4	100	300	200	2-lane warranted	Gravel warranted
T5	300	1,000	650	2-lane warranted	Paved Surface warranted
T6	1,000	3,000	2,000	2-lane warranted	Paved Surface warranted
T7	3,000	10,000	6,500	2-lane warranted	Paved Surface warranted
T8	10,000	30,000	20,000	4-lane warranted	Paved Surface warranted
T9	30,000	100,000	65,000	multi-lane warranted	Paved Surface warranted

- Standard given for illustration purposes. Proper standards are country specific.

- AADT of motorized 4-tires or more 2-way traffic

Table 4 presents the RONET default assignment of traffic levels to each traffic category per surface type. Most likely, you will not need to change the characteristics of each traffic level and the default RONET traffic level assignments to each traffic category.

Table 4. RONET Default Assignment of Traffic Levels

Surface Type	Traffic Category	Traffic Level	Average Annual Daily Traffic (AADT)			Illustrative Standards	
			Minimum (veh/day)	Maximum (veh/day)	Average (veh/day)	Geometry Standard	Pavement Standard
Earth	Traffic I	T1	0	10	5	1-lane warranted	Formation not warranted
	Traffic II	T2	10	30	20	1-lane warranted	Formation warranted
	Traffic III	T3	30	100	65	2-lane warranted	Gravel warranted
	Traffic IV	T4	100	300	200	2-lane warranted	Gravel warranted
	Traffic V	T5	300	1,000	650	2-lane warranted	Paved Surface warranted
Gravel	Traffic I	T2	10	30	20	1-lane warranted	Formation warranted
	Traffic II	T3	30	100	65	2-lane warranted	Gravel warranted
	Traffic III	T4	100	300	200	2-lane warranted	Gravel warranted
	Traffic IV	T5	300	1,000	650	2-lane warranted	Paved Surface warranted
	Traffic V	T6	1,000	3,000	2,000	2-lane warranted	Paved Surface warranted
Paved	Traffic I	T4	100	300	200	2-lane warranted	Gravel warranted
	Traffic II	T5	300	1,000	650	2-lane warranted	Paved Surface warranted
	Traffic III	T6	1,000	3,000	2,000	2-lane warranted	Paved Surface warranted
	Traffic IV	T7	3,000	10,000	6,500	2-lane warranted	Paved Surface warranted
	Traffic V	T8	10,000	30,000	20,000	4-lane warranted	Paved Surface warranted

- Standard given for illustration purposes. Proper standards are country specific.

- AADT of motorized 4-tires or more 2-way traffic

Road Condition Categories

Each network type, road type, and traffic category is subdivided into five possible road condition categories defined as a function of the engineering assessment of the capital road works (periodic maintenance or rehabilitation works) needed to bring a road to very good condition. Routine maintenance road works are needed by all roads every year; therefore, they are not considered on the definition of the road condition classes.

For paved roads, the road condition classes are defined as follows:

a) *Very Good:* Roads in very good condition require no capital road works.

b) *Good:* Roads in good condition are largely free of defects, requiring some minor maintenance works, such as preventive treatment or crack sealing.

c) *Fair:* Roads in fair condition are roads with defects and weakened structural resistance, requiring resurfacing of the pavement (periodic maintenance), but without the need to demolish the existing pavement.

d) *Poor:* Roads in poor condition require rehabilitation (strengthening or partial reconstruction).

e) *Very Poor:* Roads in very poor condition require full reconstruction, almost equivalent to new construction.

For gravel roads, the road condition classes are defined as follows:

a) *Very Good:* Roads in very good condition require no capital road works.

b) *Good:* Roads in good condition are roads that require only spot regraveling.

c) *Fair:* Roads in fair condition require regraveling (periodic maintenance).

d) *Poor:* Roads in poor condition require partial reconstruction.

e) *Very Poor:* Roads in very poor condition require full reconstruction, almost equivalent to new construction.

For earth roads, the road condition classes are defined as follows:

a) *Very Good:* Roads in very good condition require no capital road works.

b) *Good:* Roads in good condition are roads that require only spot repairs.

c) *Fair:* Roads in fair condition require heavy grading (periodic maintenance).

d) *Poor:* Roads in poor condition require partial reconstruction.

e) *Very Poor:* Roads in very poor condition require full reconstruction, almost equivalent to new construction.

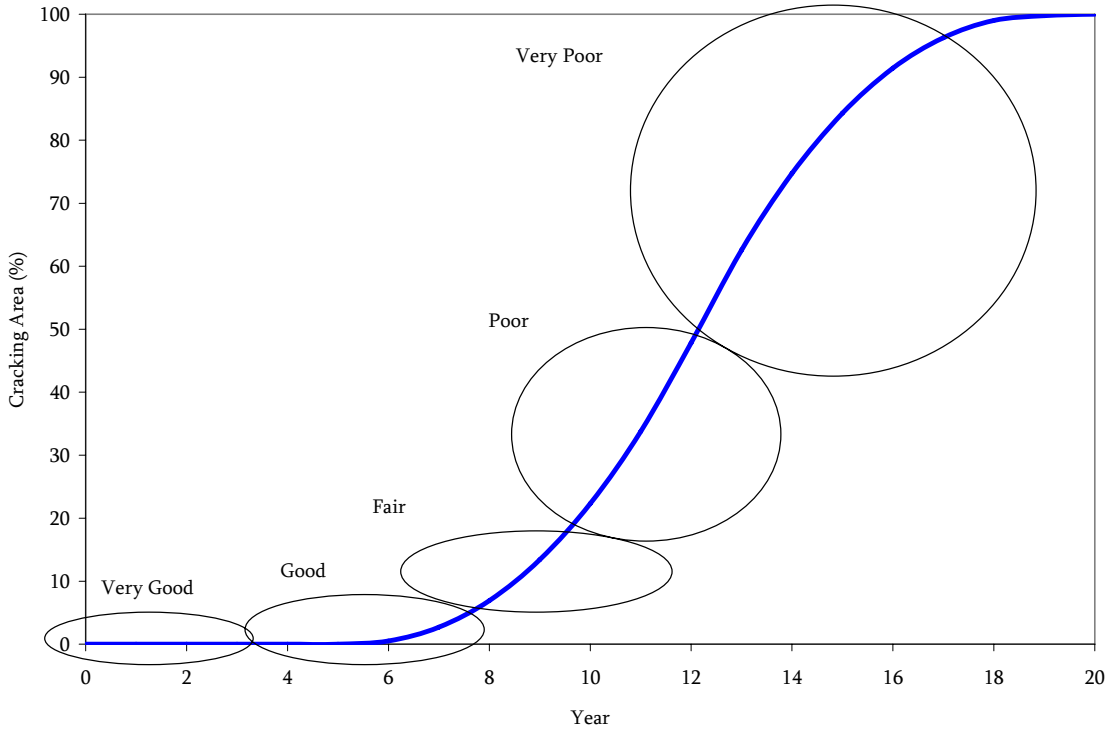
Table 5 presents a summary of the capital road works needed to bring a road to very good condition by surface type.

Table 5. Capital Road Works Needed to Bring a Road to Very Good Condition

Capital Road Works Needed to Bring a Road to Very Good Condition			
Condition Category	Bituminous Roads	Gravel Roads	Earth Roads
Very Good	None	None	None
Good	Preventive Treatment	Spot Regraveling	Spot Repairs
Fair	Resurfacing	Regraveling	Heavy Grading
Poor	Strengthening	Partial Reconstruction	Partial Reconstruction
Very Poor	Full Reconstruction	Full Reconstruction	Full Reconstruction

Figure 1 presents the road condition categories of bituminous roads, taking into account the area of cracking and the pavement age.

Figure 1. Road Condition Categories of Bituminous Roads



To assess the consequences to the road agency, the infrastructure, and the economy of applying different maintenance and rehabilitation standards, RONET needs to associate an average roughness value to each road condition category. Table 6 presents the default RONET basic characteristics of each road condition class in terms of roughness and the corresponding car speeds on a flat terrain for unpaved roads. The roughness values are country-specific and user-defined at the RONET Basic Configuration page. Note that the car speeds are given for illustrative purposes and are not being used by the RONET model.

RONET is by default configured to reflect average road characteristics that are applicable to Developing Countries conditions. If needed, RONET can be configured to reflect better local conditions. On the configuration pages, cells with bright yellow backgrounds indicate country-specific inputs that you are expected to modify, whereas cells with dim yellow background indicate user-defined RONET defaults that most likely you will not modify.

Table 6. Default RONET Basic Characteristics of Each Road Condition Class

Surface Type	Condition Category	Roughness (IRI m/km)			Speeds (km/hr)
		Minimum	Maximum	Average	
Cement Concrete	Very Good	1.0	2.5	2.0	
	Good	2.5	3.5	3.0	
	Fair	3.5	6.0	4.0	
	Poor	6.0	10.0	8.0	
	Very Poor	10.0	16.0	12.0	
Asphalt Mix	Very Good	1.0	2.5	2.0	
	Good	2.5	3.5	3.0	
	Fair	3.5	5.5	4.5	
	Poor	5.5	10.5	8.0	
	Very Poor	10.5	16.0	12.0	
Surface Treatment	Very Good	1.0	3.5	3.0	
	Good	3.5	4.5	4.0	
	Fair	4.5	6.5	5.5	
	Poor	6.5	11.5	9.0	
	Very Poor	11.5	16.0	13.0	
Gravel Roads	Very Good	1.0	6.0	5.0	90-110
	Good	6.0	9.0	7.0	70-90
	Fair	9.0	13.5	11.0	40-70
	Poor	13.5	18.0	16.0	30-40
	Very Poor	18.0	25.0	20.0	20-30
Earth Roads	Very Good	1.0	8.0	7.0	90-110
	Good	8.0	11.0	9.0	70-90
	Fair	11.0	15.5	13.0	40-70
	Poor	15.5	20.0	18.0	30-40
	Very Poor	20.0	25.0	22.0	20-30

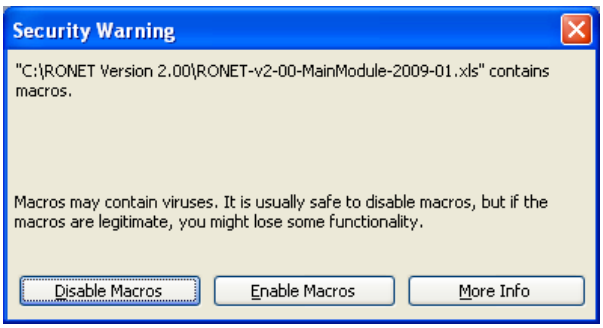
Speeds represent range of car speeds at the dry season on a flat terrain

SOFTWARE CHARACTERISTICS

RONET is implemented on a Microsoft Office Excel 2003 workbook. To run RONET, open the following Excel workbook:

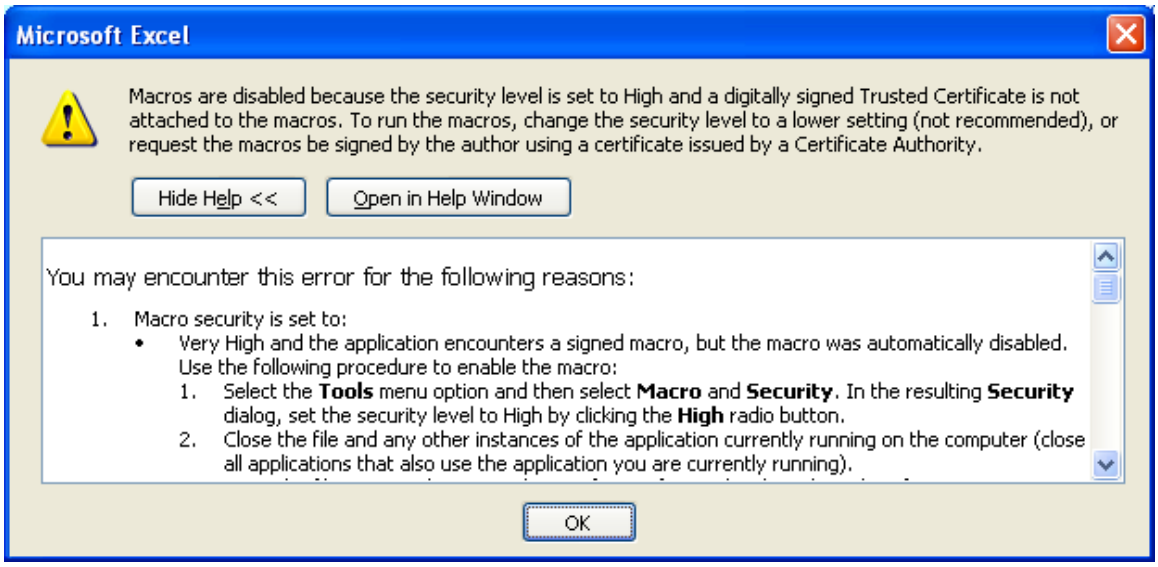
RONET v2.00-MainModule-2009-01.xls

RONET relies on Excel macros to perform its calculations; therefore, Excel has to be configured to enable Excel macros. If Excel is properly configured, you will get the following message when opening the RONET Excel workbook.



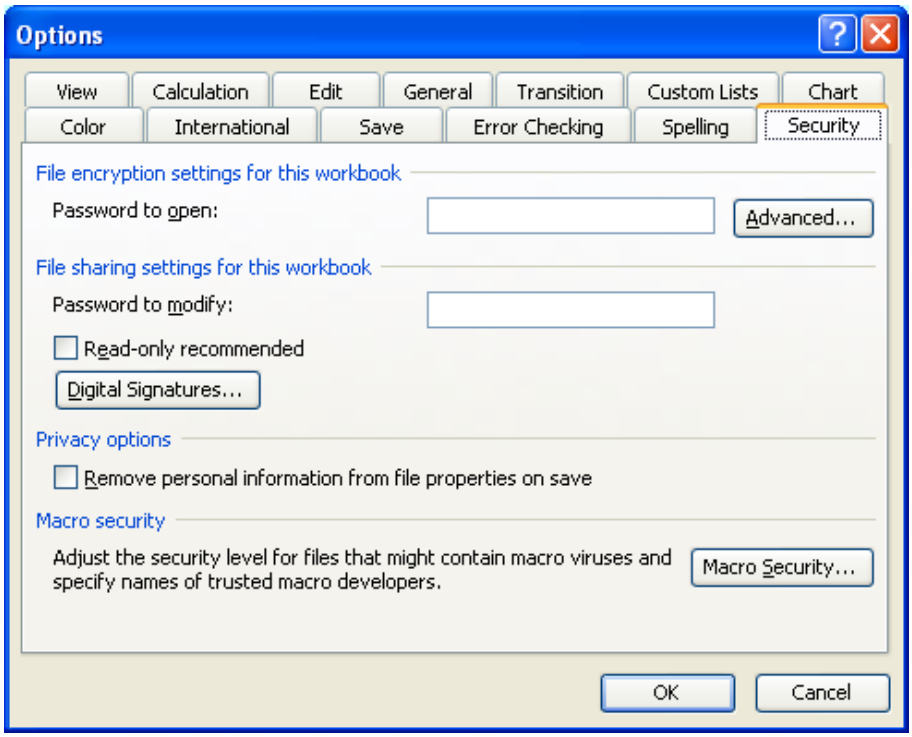
In this case, select the option "Enable Macros" to go to the RONET main menu.

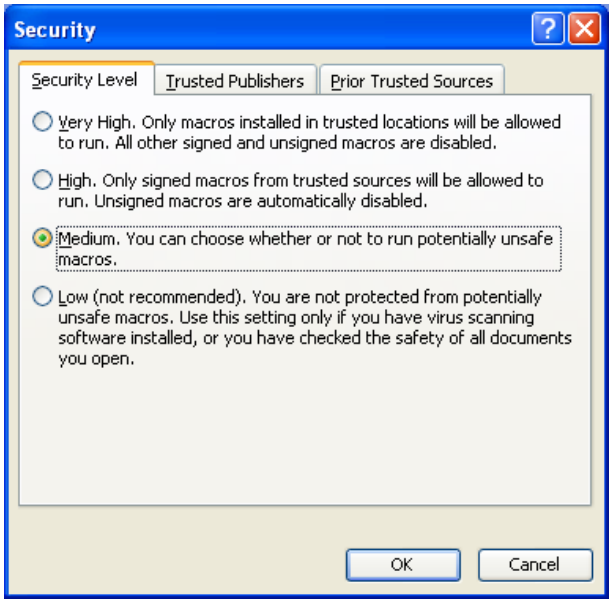
If Excel is not properly configured, you will get the following message when opening the RONET Excel workbook, indicating that the Excel security level is set to high.



To be able to run the RONET macros, you should change the Excel security level to a medium setting by following the steps below:

1. Select the **Tools** menu option of Excel and then select **Options**. At the Options tabs, select the **Security** tab and press the button **Macro Security**. In the resulting **Security** dialog, set the security level to Medium by clicking the Medium radio button. See the screenshots below.

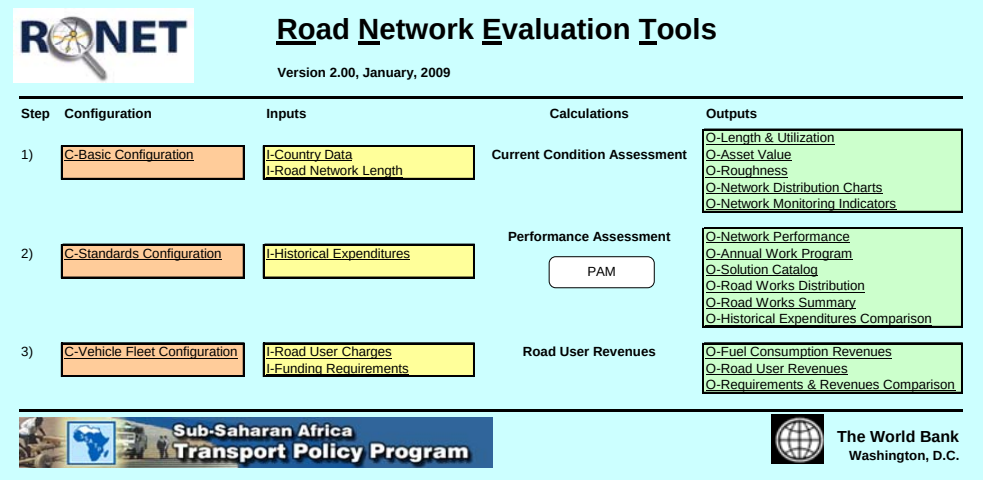




2. Close the Excel workbook and any other instances of the Excel application currently running on the computer.

3. Open the RONET Excel workbook again and click the Enable Macros button at the Security Warning dialog, to allow for the macros to run.

When you open RONET, you are presented with the following RONET main menu:



The menu is subdivided into the following areas:

- Step: presents the sequence of steps to run the model
- Configuration: presents pages where you can configure the model
- Inputs: presents pages where you enter the model input parameters
- Calculations: presents buttons that you press to perform calculations
- Outputs: presents pages that store the results of the calculations

To view a particular page, press the corresponding hyperlink (page name) and you will be directed to that page. If you are viewing a Configuration, Input, or Output page and want to return to the main menu, press the M hyperlink that is placed on the top left corner of the page (cell A1). All pages are formatted to be printed; therefore, if needed, use the Excel print options to print any page.

The first RONET module is the module that performs the network current condition assessment. On this module, there is no need to press any button to compute the results, which are all computed with Excel formulas.

The second RONET module is the module that performs the network performance assessment. To use this module, you first have to enter the configuration and inputs of the current condition assessment module. On this module, there is a need to press the corresponding "Performance Assessment" button to compute the results, which are computed using Excel macros. Note the following:

- When you press the Performance Assessment button, RONET asks if you want to keep the intermediate results of the calculations on a temporary workbook. If you select Yes, all the intermediate results are stored on a new workbook created automatically by RONET. The new workbooks are named "Book1," "Book2," "Book3," and so on. Once you are done reviewing a temporary workbook, you can close it or save it if necessary (saving with a different name if necessary). If you select No, then no temporary workbook is created.

- To compute the results takes between two and five minutes, depending on the computer processing speed. The status of the calculations is presented on the Excel status line at the bottom left corner of the screen. When all the calculations are done, the model presents a message indicating the end of the calculations and the duration of the calculations.

The third RONET module is the module that computes the revenues collected from road user charges and compares them with the financing needs. To use this module, you first have to enter the configuration and inputs of the current condition assessment and performance assessment modules and execute the "Performance Assessment" button of the performance assessment module. On the road user revenues module, there is no need to press any button to compute the results, which are all computed with Excel formulas.

When you are displaying a Configuration, Input, or Output page, you will notice that some cells have a yellow background. These cells with the yellow backgrounds are input cells where you enter your input data or your model output choices. Cells with bright yellow backgrounds indicate country-specific inputs that you are expected to modify, whereas cells with dim yellow backgrounds indicate user-defined RONET defaults that most likely you will not need to modify. All the cells with a white background contain labels (black font) or formulas (blue font). You are only allowed to edit the input cells with yellow backgrounds because all other cells are protected. If you need to unprotect a page, select the Tools menu option of Excel, and then select Protection and Unprotect Sheet.

RONET can be used with any currency, but the numerical fields and decimal places are set up to fit U.S. dollars and all RONET default values are provided in U.S. dollars. If you decide to use any other currency, you have to be careful to enter all the inputs and default values using the same currency on all RONET configuration and input pages. In that case, all the results will be presented in that currency.

To carry out a current condition assessment, follow the steps below.

- If necessary, modify the basic configuration
- Enter the country data
- Enter the network data
- View and the corresponding output pages

To carry out a performance assessment, follow the steps below.

- If necessary, modify the basic configuration, if you had not done that before
- If necessary, modify the standards configuration
- Enter the country data, if you had not done that before
- Enter the network data, if you had not done that before
- Optionally, enter the historical expenditures data
- Press the "Performance Assessment" button and wait for the calculations to be completed
- View and the corresponding output pages, selecting on row 1 a corresponding budget scenario,, network surface class, road work type, or period

To carry out a road user revenues evaluation, follow the steps below.

- Carry out a current condition assessment and a performance assessment

- If necessary, modify the vehicle fleet configuration
- Enter the road user charges data
- Enter the funding requirements data
- View and the corresponding output pages

Part B — Current Condition Assessment Module

Current Condition Assessment Overview

This RONET module evaluates the current network condition and presents summary network statistics and network monitoring indicators. The outputs of this module are the following.

- Length & Utilization: presents the network length and network utilization distribution by network type and surface type
- Asset Value: presents the network maximum asset value and network current asset value distribution by network type and surface type
- Roughness: presents the average network roughness weighted by km and the average network roughness weighted by vehicle-km by network type and surface type
- Network Distribution Charts: presents network distribution charts of the network length, utilization, and maximum and current asset value by network type and surface type
- Network Monitoring Indicators: presents road network monitoring indicators

All the results are computed using Excel formulas; therefore, there is no button to press to compute the results which are recomputed automatically when you change any configuration data or input data. The Output pages contain tables and charts and are formatted to be printed; therefore, if necessary, use the Excel print options to print these pages.

Basic Configuration

Management Types

On the Basic Configuration page, the first option is to define the possible management responsibility types present in the country. RONET shows, as one of its outputs, the required road agency costs and other indicators summarized by these management types. The default management types are given below:

- *Private* sector: roads that are under the jurisdiction of concessionaires
- *National* road agency: roads that are under the jurisdiction of the national road agency
- *Regional* road agencies: roads that are under the jurisdiction of regional, provincial or state governments
- *Local* road agencies: roads under the jurisdiction of district or local governments
- *Urban* municipalities: roads, streets and avenues that are under the jurisdiction of city or town governments

Network Types

The second option defines the names of the five network types characterized for a country or partial road network. For example, one can subdivide a network by functional classification, geographical region, or terrain. The default values define the network types by functional classification (Motorway, Primary, Secondary, Tertiary or Unclassified) as shown in table 7.

Table 7. Network Types

Network Type	Terrain Type (1 to 3)	Environment Type (1 to 23)	Management Type
Motorways	2	12	National
Primary	2	12	National
Secondary	2	12	Regional
Tertiary	2	12	Local
Unclassified	2	12	Local

The network types can be defined differently on different countries. For example, in China, the network types could be defined as: Expressway, Class I, Class II, Class III, and Class IV roads, and on another country, where all roads are managed by only one road entity, the network types could represent different regions of the country: North, South, Center, East, and West. On another country, one could add urban streets and avenues to the evaluation. Therefore, it is expected that most users will configure the definition of the network types to reflect local conditions. Some examples are given in table 8.

Table 8. Default and Alternative Configurations

	Default Configuration	Alternative Configurations Examples	
Network Type	Types by Functional Class	Types by Geographic Region	Types by Terrain Type
1	Motorways	North Region	Flat Terrain
2	Primary	South Region	Hilly Terrain
3	Secondary	Eastern Region	Mountainous Terrain
4	Tertiary	Western Region	NA
5	Unclassified	Central Region	NA

Once the network types are defined, you then define, for each network type, the average terrain type (1 to 3), environment type (1 to 23), and the management entity (management type) responsible for management of the network type. Each terrain type and environment type is identified by an identification number.

Terrain Types

The average physical characteristics of the three possible terrain types (1-flat, 2-hilly or 3-mountainous) vary by country; therefore, they are defined at the Basic Configuration page. Here you enter the corresponding average Rise & Fall, in m/km, and Horizontal Curvature, in degrees/km, of each terrain type, following the HDM-4 definitions of Rise & Fall and Horizontal Curvature. The default RONET values given in table 9 are based on worldwide averages. It is expected that you will adjust these values to reflect local conditions only if local data are readily available on existing HDM-4 studies.

Table 9. Terrain Types

Terrain Type (1 to 3)	Terrain Classification	Rise & Fall (m/km)	Horizontal Curvature (deg/km)
1	Flat	0	0
2	Hilly	40	100
3	Mountainous	80	300

Environmental Types

The Basic Configuration page allows for the definition of 23 possible environment types defined by function of the moisture and temperature classification. Here you can enter, for each environment type, the average rainfall, in mm/month, and the HDM-4 environment coefficient of road deterioration for paved roads. The default values are given below in Table 10. It is expected that very few users will modify the environmental coefficients of road deterioration for paved roads. These coefficients can only be adjusted after a detailed calibration of the HDM-4 road deterioration equations, which typically is not readily available.

Table 10. Environment Types

Environment Type (1 to 23)	Moisture Classification	Temperature Classification	Rainfall (mm/month)	Environment Coefficient (#)
1	Arid	Tropical	15	0.005
2	Arid	Sub-tropical Hot	15	0.100
3	Arid	Sub-tropical Cool	15	0.015
4	Arid	Temperate Cool	15	0.025
5	Arid	Temperate Freeze	15	0.040
6	Semi-arid	Tropical	50	0.010
7	Semi-arid	Sub-tropical Hot	50	0.015
8	Semi-arid	Sub-tropical Cool	50	0.025
9	Semi-arid	Temperate Cool	50	0.035
10	Semi-arid	Temperate Freeze	50	0.060
11	Sub-humid	Tropical	100	0.020
12	Sub-humid	Sub-tropical Hot	100	0.025
13	Sub-humid	Sub-tropical Cool	100	0.040
14	Sub-humid	Temperate Cool	100	0.060
15	Sub-humid	Temperate Freeze	100	0.100
16	Humid	Tropical	175	0.025
17	Humid	Sub-tropical Hot	175	0.030
18	Humid	Sub-tropical Cool	175	0.060
19	Humid	Temperate Cool	175	0.100
20	Humid	Temperate Freeze	175	0.200
21	Per-humid	Tropical	210	0.030
22	Per-humid	Sub-tropical Hot	210	0.040
23	Per-humid	Sub-tropical Cool	210	0.070

Road Condition Classes

The next Basic Configuration page option is to define (per surface type) for each of the five road condition categories (Very Good, Good, Fair, Poor and Very Poor), the roughness characteristics (average, minimum, and maximum), the number of years since the last periodic maintenance or rehabilitation road work, and the estimate of the percent of roads that are seasonal. The default values are given in table 11. It is expected that few users will modify the default roughness values and the years since the last periodic maintenance or rehabilitation road work. Users in other regions might adjust these values to reflect local conditions. Users might want to adjust the percent of roads that are seasonal, which is a rough estimate of the percent of the road in each road condition class that are not all-weather roads, because this is a country-specific input.

Table 11. Default Values for Road Condition Classes

Surface Type	Condition Category	Avg. Roughness (IRI)	Min. Roughness (IRI)	Max. Roughness (IRI)	Last Periodic Maint. (years)	Percent of Roads that are Seasonal (%)
Cement Concrete	Very Good	2.0	1.0	2.5	1	0%
	Good	3.0	2.5	3.5	5	0%
	Fair	4.0	3.5	6.0	10	0%
	Poor	8.0	6.0	10.0	15	0%
	Very Poor	12.0	10.0	16.0	20	0%
Asphalt Mix	Very Good	2.0	1.0	2.5	1	0%
	Good	3.0	2.5	3.5	5	0%
	Fair	4.5	3.5	5.5	10	0%
	Poor	8.0	5.5	10.5	15	0%
	Very Poor	12.0	10.5	16.0	20	0%
Surface Treatment	Very Good	3.0	1.0	3.5	1	0%
	Good	4.0	3.5	4.5	5	0%
	Fair	5.5	4.5	6.5	10	0%
	Poor	9.0	6.5	11.5	15	0%
	Very Poor	13.0	11.5	16.0	20	0%
Gravel	Very Good	5.0	1.0	6.0	NA	0%
	Good	7.0	6.0	9.0	NA	0%
	Fair	11.0	9.0	13.5	NA	0%
	Poor	16.0	13.5	18.0	NA	100%
	Very Poor	20.0	18.0	25.0	NA	100%
Earth	Very Good	7.0	1.0	8.0	1	100%
	Good	9.0	8.0	11.0	2	100%
	Fair	13.0	11.0	15.5	3	100%
	Poor	18.0	15.5	20.0	4	100%
	Very Poor	22.0	20.0	25.0	5	100%

Traffic Levels

RONET considers nine possible traffic levels (T1 to T9). At the Basic Configuration page, you define the average, minimum and maximum daily traffic of each traffic level. The default values are given in table 12. It is expected that few users will modify these default values.

Table 12. Default Values for Traffic Levels

Traffic Level	Avg. Traffic (AADT)	Min. Traffic (AADT)	Max. Traffic (AADT)
T1	5	0	10
T2	20	10	30
T3	65	30	100
T4	200	100	300
T5	650	300	1,000
T6	2,000	1,000	3,000
T7	6,500	3,000	10,000
T8	20,000	10,000	30,000
T9	65,000	30,000	100,000

Traffic Categories

Finally, you define the traffic level that is associated to each of the five traffic category (Traffic I, Traffic II, Traffic III, Traffic IV, and Traffic V), per surface type, and the structural number of each traffic category for paved roads. The structural number represents the modified structural number at the time of construction or last rehabilitation of the road, computed as defined on the HDM-III[7] documentation, equal to the structural number computed following American Association of State Highway & Transportation Officials (AASHTO) guidelines, plus adding the strength contribution of subgrade. The default values are given in table 13. It is expected that very few users will modify these default traffic levels per traffic category.

Table 13. Default Values for Traffic Categories

Surface Type	Traffic Category	Traffic Level (T1 to T9)	Avg. Traffic (AADT)	Min. Traffic (AADT)	Max. Traffic (AADT)	Structural Number for Paved Roads (#)
Cement Concrete	Traffic I	T4	200	100	300	6.0
	Traffic II	T5	650	300	1000	6.0
	Traffic III	T6	2000	1000	3000	6.0
	Traffic IV	T7	6500	3000	10000	6.0
	Traffic V	T8	20000	10000	30000	8.0
Asphalt Mix	Traffic I	T4	200	100	300	1.5
	Traffic II	T5	650	300	1000	2.0
	Traffic III	T6	2000	1000	3000	3.0
	Traffic IV	T7	6500	3000	10000	5.0
	Traffic V	T8	20000	10000	30000	8.0
Surface Treatment	Traffic I	T4	200	100	300	1.5
	Traffic II	T5	650	300	1000	2.0
	Traffic III	T6	2000	1000	3000	3.0
	Traffic IV	T7	6500	3000	10000	5.0
	Traffic V	T8	20000	10000	30000	8.0
Gravel	Traffic I	T2	20	10	30	NA
	Traffic II	T3	65	30	100	NA
	Traffic III	T4	200	100	300	NA
	Traffic IV	T5	650	300	1000	NA
	Traffic V	T6	2000	1000	3000	NA
Earth	Traffic I	T1	5	0	10	NA
	Traffic II	T2	20	10	30	NA
	Traffic III	T3	65	30	100	NA
	Traffic IV	T4	200	100	300	NA
	Traffic V	T5	650	300	1000	NA

COUNTRY DATA

On this page you enter the basic country data that is composed of the following elements:

- Name and Year
- Basic Characteristics
- Traffic Growth Rate
- Capital Road Works Unit Costs
- Recurrent Maintenance Works Unit Costs
- Traffic Levels Characteristics
- Vehicle Fleet Unit road User Costs Relationship to Roughness
- Accident Rates
- Accident Costs

Name and Year

Here you enter the name of the country, or the name of the region of the country or road agency being evaluated. RONET is set up to evaluate an entire road network of a country, but in some circumstances RONET can be used to evaluate only a region of a country; for example, a state or a province of a country or a partial network managed by a road agency. Here you also enter the year of the road network data and basic country characteristics. The year is entered for reference purposes; it is not used in the calculations.

Basic Characteristics

At this table, you enter the country figures that are used to compute network monitoring indicators, as well as by the network performance assessment and road revenues modules:

- Land area (sq km): a country's total area, excluding areas under inland bodies of water and some coastal waterways
- Total population (million persons): the mid-year estimates of all residents regardless of legal status or citizenship
- Rural population (million persons): the mid-year population of areas defined as rural in each country and reported to the United Nations
- GDP at current prices ($ billion): the gross domestic product at current prices that is the sum of the gross value added by all resident producers in the economy, plus any product taxes and minus any subsidies not included in the value of the products
- Vehicle fleet (vehicles): the total number of road motor vehicles in use at the given year in the country
- Total road network length (km): the total road network length of the country
- Total paved roads network length (km): the total paved roads network length of the country
- Diesel roads consumption (million liters/year): the total annual diesel consumption in the road sector
- Gasoline roads consumption (million liters/year): the total annual gasoline consumption in the road sector
- Total accidents fatalities (persons/year): the total accident fatalities registered on the country
- Total accidents serious injuries (persons/year): the total accidents serious injuries registered on the country.
- Discount rate (%): the planning discount rate adopted by the country, which is typically 12% in developing countries.

The first four of these indicators can be found at the following World Bank website page:

http://go.worldbank.org/45B5H20NV0

Traffic Growth Rate

You define the expected annual traffic growth rate over the 20-year evaluation period for each network type.

> The RONET default values for basic characteristics and for traffic growth rate are for a *fictitious country*; therefore, you must change them to reflect local conditions.

Capital Road Works Unit Costs

On RONET, the road agency road works are classified in the following manner:

- Capital Road Works
  - Periodic Maintenance
  - Rehabilitation
  - New Construction
- Recurrent Maintenance Works
  - Annual Works On and Outside de Carriageway

Here you enter the financial unit costs of the capital road works defined for each surface type, in $ per km for a two-lane road. RONET works with two-lane equivalent road classes. The possible capital road works, which are a function of the current road condition and network type, are shown in table 14.

Strengthening and reconstruction of paved roads and partial reconstruction, or full reconstruction of unpaved roads are considered as rehabilitation works. The road works applied to roads in good and fair condition are considered periodic maintenance works.

Table 14. Possible Capital Road Works

Surface	Current Condition	Road Work Type	Road Work Class
Cement Concrete	Good Condition	Preventive Treatment	Periodic Maintenance
	Fair Condition	Resurfacing (Overlay)	Periodic Maintenance
	Poor Condition	Strengthening (Overlay)	Rehabilitation
	Very Poor Condition	Reconstruction	Rehabilitation
	No Road	New Construction	New Construction
Asphalt Mix	Good Condition	Preventive Treatment	Periodic Maintenance
	Fair Condition	Resurfacing (Overlay)	Periodic Maintenance
	Poor Condition	Strengthening (Overlay)	Rehabilitation
	Very Poor Condition	Reconstruction	Rehabilitation
	No Road	New Construction	New Construction
Surface Treatment	Good Condition	Preventive Treatment	Periodic Maintenance
	Fair Condition	Resurfacing (Reseal)	Periodic Maintenance
	Poor Condition	Strengthening (Overlay)	Rehabilitation
	Very Poor Condition	Reconstruction	Rehabilitation
	No Road	New Construction	New Construction
Gravel Roads	Good Condition	Spot Regraveling	Periodic Maintenance
	Fair Condition	Regraveling	Periodic Maintenance
	Poor Condition	Partial Reconstruction	Rehabilitation
	Very Poor Condition	Full Reconstruction	Rehabilitation
	No Road	New Construction	New Construction
Earth Roads	Good Condition	Spot Repairs	Periodic Maintenance
	Fair Condition	Heavy Grading	Periodic Maintenance
	Poor Condition	Partial Reconstruction	Rehabilitation
	Very Poor Condition	Full Reconstruction	Rehabilitation
	No Road	New Construction	New Construction

The unit costs of the capital works could vary by network type (different functional classification or different region of the country), for example, because of different design standards; therefore, if necessary, you can enter different values by network type. Here you also need to define the basic characteristics of the regraveling, resurfacing, strengthening, and reconstruction options in terms of surface layer thickness for regraveling, resurfacing, and strengthening, and resulting modified structural number and roughness for reconstruction.

The default values are given in table 15. It is expected that you will modify these default values to reflect local conditions. The default values reflect broadly developing countries conditions and were derived by evaluating the World Bank's Road Costs Knowledge System[5] (ROCKS) that stores and evaluates information on road works unit costs worldwide, and can be download at the following World Bank Website:

http://worldbank.org/roadsoftwaretools/

Table 15. Default Values in Capital Road Works Unit Costs

Capital Road Works Unit Costs

				Two-Lane Unit Costs of Road Works ($/km)					Thickness	Reconstruction	
Surface Type	Current Condition	Road Work Class	Road Work Type	Motorways	Primary	Secondary	Tertiary	Unclassified	(mm)	Structural No.	Roughness (IRI)
Cement Concrete	Good Condition	Periodic Maintenance	Preventive Treatment	12,000	12,000	12,000	8,571	8,571			
	Fair Condition		Resurfacing (Overlay)	100,000	100,000	100,000	71,429	71,429	50		
	Poor Condition	Rehabilitation	Strengthening (Overlay)	200,000	200,000	200,000	142,857	142,857	100		
	Very Poor Condition		Reconstruction	330,000	330,000	330,000	235,714	235,714		3	2.0
	No Road	New Construction	New Construction	400,000	400,000	400,000	285,714	285,714			
Asphalt Mix	Good Condition	Periodic Maintenance	Preventive Treatment	12,000	12,000	12,000	8,571	8,571			
	Fair Condition		Resurfacing (Overlay)	100,000	100,000	100,000	71,429	71,429	50		
	Poor Condition	Rehabilitation	Strengthening (Overlay)	200,000	200,000	200,000	142,857	142,857	100		
	Very Poor Condition		Reconstruction	330,000	330,000	330,000	235,714	235,714		3	2.0
	No Road	New Construction	New Construction	400,000	400,000	400,000	285,714	285,714			
Surface Treatment	Good Condition	Periodic Maintenance	Preventive Treatment	12,000	12,000	12,000	8,571	8,571			
	Fair Condition		Resurfacing (Reseal)	27,000	27,000	27,000	19,286	19,286	12		
	Poor Condition	Rehabilitation	Strengthening (Overlay)	160,000	160,000	160,000	114,286	114,286	80		
	Very Poor Condition		Reconstruction	260,000	260,000	260,000	185,714	185,714		2	2.5
	No Road	New Construction	New Construction	330,000	330,000	330,000	235,714	235,714			
Gravel	Good Condition	Periodic Maintenance	Spot Regravelling	3,000	3,000	3,000	2,143	2,143			
	Fair Condition		Regravelling	17,000	17,000	17,000	12,143	12,143	150		
	Poor Condition	Rehabilitation	Partial Reconstruction	40,000	40,000	40,000	28,571	28,571			
	Very Poor Condition		Full Reconstruction	60,000	60,000	60,000	42,857	42,857			
	No Road	New Construction	New Construction	80,000	80,000	80,000	57,143	57,143			
Earth	Good Condition	Periodic Maintenance	Spot Repairs	200	200	200	143	143			
	Fair Condition		Heavy Grading	800	800	800	571	571			
	Poor Condition	Rehabilitation	Partial Reconstruction	8,000	8,000	8,000	5,714	5,714			
	Very Poor Condition		Full Reconstruction	25,000	25,000	25,000	17,857	17,857			
	No Road	New Construction	New Construction	40,000	40,000	40,000	28,571	28,571			

Recurrent Road Works Unit Costs

Here you enter the financial unit costs of the recurrent road works for each surface type, in $ per km per year for a two-lane road. The recurrent road works unit costs vary by current road condition and network type; therefore, if necessary, you can enter different values by road condition and network type. Here you enter the total recurrent costs that are the sum of the annual road works done on the carriageway (for example, grading, pothole patching, and so forth), and the annual road works done outside the carriageway (for example, shoulder repairs, grass mowing, and so forth). The default values, which reflect broadly developing country conditions, are given in table 16. It is expected that you will modify these default values to reflect local conditions.

Table 16. Default Values for Recurrent Maintenance Works Unit Costs

Recurrent Maintenance Works Unit Costs

				Two-Lane Unit Costs of Road Works ($/km-year)				
Surface Type	Road Condition	Road Work Class	Road Work Type	Motorways	Primary	Secondary	Tertiary	Unclassified
Cement Concrete	Very Good	Recurrent Maintenance	Recurrent Maintenance	2,000	2,000	2,000	1,000	1,000
	Good		Recurrent Maintenance	2,500	2,500	2,500	1,250	1,250
	Fair		Recurrent Maintenance	3,000	3,000	3,000	1,500	1,500
	Poor		Recurrent Maintenance	1,500	1,500	1,500	750	750
	Very Poor		Recurrent Maintenance	1,500	1,500	1,500	750	750
Asphalt Mix	Very Good	Recurrent Maintenance	Recurrent Maintenance	2,000	2,000	2,000	1,000	1,000
	Good		Recurrent Maintenance	2,500	2,500	2,500	1,250	1,250
	Fair		Recurrent Maintenance	3,000	3,000	3,000	1,500	1,500
	Poor		Recurrent Maintenance	1,500	1,500	1,500	750	750
	Very Poor		Recurrent Maintenance	1,500	1,500	1,500	750	750
Surface Treatment	Very Good	Recurrent Maintenance	Recurrent Maintenance	2,000	2,000	2,000	1,000	1,000
	Good		Recurrent Maintenance	2,500	2,500	2,500	1,250	1,250
	Fair		Recurrent Maintenance	3,000	3,000	3,000	1,500	1,500
	Poor		Recurrent Maintenance	1,500	1,500	1,500	750	750
	Very Poor		Recurrent Maintenance	1,500	1,500	1,500	750	750
Gravel	Very Good	Recurrent Maintenance	Recurrent Maintenance	1,000	1,000	1,000	500	500
	Good		Recurrent Maintenance	1,250	1,250	1,250	626	626
	Fair		Recurrent Maintenance	1,500	1,500	1,500	750	750
	Poor		Recurrent Maintenance	750	750	750	375	375
	Very Poor		Recurrent Maintenance	750	750	750	375	375
Earth	Very Good	Recurrent Maintenance	Recurrent Maintenance	300	300	300	150	150
	Good		Recurrent Maintenance	450	450	450	225	225
	Fair		Recurrent Maintenance	600	600	600	300	300
	Poor		Recurrent Maintenance	300	300	300	150	150
	Very Poor		Recurrent Maintenance	300	300	300	150	150

Traffic Levels Characteristics

On the Basic Configuration page, nine possible traffic levels (T1 to T9) are defined by characterizing their average, minimum, and maximum Average Annual Daily Traffic (AADT). Here you define the average traffic composition of each traffic level and define for each vehicle type: (i) the equivalent standard axles (ESA per vehicle), (ii) the average cargo payload per vehicle (tons per vehicle), and (iii) the

average number of passengers per vehicle (passengers per vehicle). Based on this information, RONET computes for each traffic level: (i) the total equivalent standard axles per year, in million ESA per year, (ii) the average cargo payload per vehicle, in tons per vehicle, and (iii) the average number of passengers per vehicle, in passengers per vehicle. The ESA loading is used to compute the road deterioration of paved roads and the average payload and passengers per vehicle are used to compute the network monitoring indicators: annual freight carried over road network (annual ton-km) and annual passengers carried over road network (annual passenger-km).

The default values, which reflect broadly developing country conditions, are given in table 17. It is expected that you will calibrate these default values to reflect local conditions.

Table 17. Default Values for Traffic Levels Characteristics

		Traffic Level	T1	T2	T3	T4	T5	T6	T7	T8	T9
		Average Annual Daily Traffic (AADT) =	5	20	65	200	650	2,000	6,500	20,000	65,000
Vehicle	Equivalent Standard Axles	Cargo Payload	Passengers	Typical Traffic Composition (%)								
Type	(ESA/vehicle)	(Tons/vehicle)	ersons/vehic	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Motorcycle	0.00	0.20	1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Car Small	0.00	0.10	2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Car Medium	0.00	0.30	2	24.4%	24.4%	24.4%	24.4%	29.8%	29.8%	29.8%	34.1%	34.1%
Delivery Vehicle	0.01	0.90	2	33.3%	33.3%	33.3%	33.3%	27.2%	27.2%	27.2%	26.8%	26.8%
Four-Wheel Drive	0.02	0.80	2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Truck Light	0.10	2.40	1	8.9%	8.9%	8.9%	8.9%	6.7%	6.7%	6.7%	4.5%	4.5%
Truck Medium	1.25	5.70	1	10.5%	10.5%	10.5%	10.5%	7.8%	7.8%	7.8%	4.9%	4.9%
Truck Heavy	2.28	10.60	1	3.3%	3.3%	3.3%	3.3%	3.4%	3.4%	3.4%	2.5%	2.5%
Truck Articulated	4.63	22.30	1	2.7%	2.7%	2.7%	2.7%	4.5%	4.5%	4.5%	3.0%	3.0%
Bus Light	0.04	1.25	12	10.6%	10.6%	10.6%	10.6%	15.0%	15.0%	15.0%	16.4%	16.4%
Bus Medium	0.70	2.50	30	3.2%	3.2%	3.2%	3.2%	2.8%	2.8%	2.8%	3.9%	3.9%
Bus Heavy	0.80	3.20	40	3.2%	3.2%	3.2%	3.2%	2.8%	2.8%	2.8%	3.9%	3.9%
			Total =	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
			ESA Loading (M ESA/year) =	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			Payload/Vehicle (tons/vehicle) =	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Passengers/Vehicle (persons/vehicle) =	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Vehicle Fleet Unit Road User Costs Relationship to Roughness

RONET computes the network road user costs for different maintenance and rehabilitation standards at the performance assessment module. Road user costs are a function of road roughness; therefore, there is a need to define the relationship between unit road user costs and roughness for a particular country. On RONET, this relationship takes the form of the following cubic polynomial.

Unit Road User Costs ($/vehicle-km) = a0 + a1*IRI + a2*IRI^2 + a3*IRI^3

Where "Unit Road User Costs" represents the unit road use costs of the vehicle fleet, "IRI" is the roughness of the road, in IRI, m/km, and a0, a1, a2 and a3 are coefficients of the cubic polynomial.

Here you need to define the coefficients of the cubic polynomial for each traffic level based on local conditions. To compute these coefficients effortlessly, you can use the World Bank's Road User Costs Knowledge System (RUCKS)[6] version 1.2 that contains an Excel model designed for this purpose, and presents representative vehicle fleet characteristics for different regions of the World. RUCKS can be downloaded at the following World Bank Website:

http://worldbank.org/roadsoftwaretools/.

When you compute unit user costs with RUCKS or with any other model, you compute either financial (market costs) or economic (without taxes and subsidies) road user costs. RONET compares road agency and road user in financial terms to simplify the evaluation compared with the HDM-4 model that compares economic costs, because most of the time HDM-4 users adopt the same conversion factor to road agency costs and road user costs; therefore, there is a RONET input factor that represents the factor to multiply the defined unit road user costs computed by the cubic polynomials to convert them to financial costs. If the cubic polynomials are already computing financial costs then the multiplier factor is 1.0. The default values, which reflect broadly developing country conditions, are given below in table 18. It is expected that you will modify these default values to reflect local conditions.

Table 18. Vehicle Fleet Unit Road User Costs Default Values

	Traffic Level	T1	T2	T3	T4	T5	T6	T7	T8	T9
	Average Annual Daily Traffic (AADT)	5	20	65	200	650	2,000	6,500	20,000	65,000
Unit Road User Costs ($/veh-km) = a0										
+ a1*IRI + a2*IRI^2 + a3*IRI^3	a0 coefficient	0.27966	0.27966	0.27966	0.27966	0.28871	0.28871	0.28840	0.27267	0.41310
	a1 coefficient	-0.00028	-0.00028	-0.00028	-0.00028	-0.00055	-0.00055	-0.00060	-0.00222	0.00613
	a2 coefficient	0.00144	0.00144	0.00144	0.00144	0.00148	0.00148	0.00151	0.00173	0.00049
	a3 coefficient	-0.00003	-0.00003	-0.00003	-0.00003	-0.00003	-0.00003	-0.00003	-0.00004	-0.00002
Factor to multiply defined unit road user costs above to convert them to	1.00									

Accident Rates and Accident Costs

RONET estimates the total annual fatalities and serious injuries due to road accidents in the road network based on average fatalities and serious injuries rates (number per 100 million vehicle-km) per surface type. To compute the road safety costs, (i) you enter a multiplier to the GDP per capita defined to obtain the costs of a fatality to society, with suggested range 60 to 80 as given by the International Road Assessment Programme (iRAP) publication: The True Cost of Road Crashes [8], and (ii) you enter the serious injury costs as a percentage of the fatality cost, with suggested range 20% to 30%. The default values, which reflect broadly developing countries conditions, are given below in table 19.

Table 19. Accident Rates and Costs

Accident Rates	Motorways	Primary	Secondary	Tertiary	Unclassified
Fatalities accident rate (number of fatalities per 100 million vehicle-km)	10	10	10	10	10
Serious injuries accident rate (number of serious injuries per 100 million vehicle-km)	100	100	100	100	100

Acciddent Costs			
Factor to multiply GDP per capita to obtain fatality cost	70	Fatalities accident cost ($)	64,400
Serious injuries cost as a percent of fatality cost	25%	Serious injuries accident cost ($)	16,100

ROAD NETWORK LENGTH

On this page you enter the network length distribution by network type, surface type, traffic category, and road condition category. You should enter the two-lane equivalent network length belonging to each road class, in kilometers. That means if there is a four- lane road, you should enter the corresponding two-lane equivalent length, which is twice the length of the four-lane road. If there are no kilometers on the network represented by a road class, you can enter zero kilometers or leave the cell blank. Figure 2 presents the structure of this page.

Figure 2. Road Network Length Default Values (Country XYZ)

Road Network Two-Lane Equivalent Length (km)

Primary
Surface Treatment

Traffic (AADT) \ Condition (IRI)		Very Good 3	Good 4	Fair 5.5	Poor 9	Very Poor 13	Total
Traffic I	<300	0.0	0.0	0.0	0.0	0.0	0.0
Traffic II	300-1000	0.0	51.0	36.0	62.0	26.0	175.0
Traffic III	1000-3000	4.0	13.0	67.0	88.0	32.0	204.0
Traffic IV	3000-10000	0.0	0.0	0.0	0.0	0.0	0.0
Traffic V	>10000	0.0	0.0	0.0	0.0	0.0	0.0
Total		4.0	64.0	103.0	150.0	58.0	379.0

Primary
Gravel

Traffic (AADT) \ Condition (IRI)		Very Good 5	Good 7	Fair 11	Poor 16	Very Poor 20	Total
Traffic I	<30	0.0	0.0	0.0	49.0	292.0	341.0
Traffic II	30-100	0.0	5.0	11.0	7.0	179.0	202.0
Traffic III	100-300	0.0	0.0	0.0	0.0	0.0	0.0
Traffic IV	300-1000	0.0	0.0	0.0	0.0	0.0	0.0
Traffic V	>1000	0.0	0.0	0.0	0.0	0.0	0.0
Total		0.0	5.0	11.0	56.0	471.0	543.0

Secondary
Surface Treatment

Traffic (AADT) \ Condition (IRI)		Very Good 3	Good 4	Fair 5.5	Poor 9	Very Poor 13	Total
Traffic I	<300	0.0	0.0	10.0	0.0	0.0	10.0
Traffic II	300-1000	0.0	0.0	3.0	56.0	47.0	106.0
Traffic III	1000-3000	18.0	8.0	47.0	61.0	5.0	139.0
Traffic IV	3000-10000	0.0	0.0	0.0	0.0	0.0	0.0
Traffic V	>10000	0.0	0.0	0.0	0.0	0.0	0.0
Total		18.0	8.0	60.0	117.0	52.0	255.0

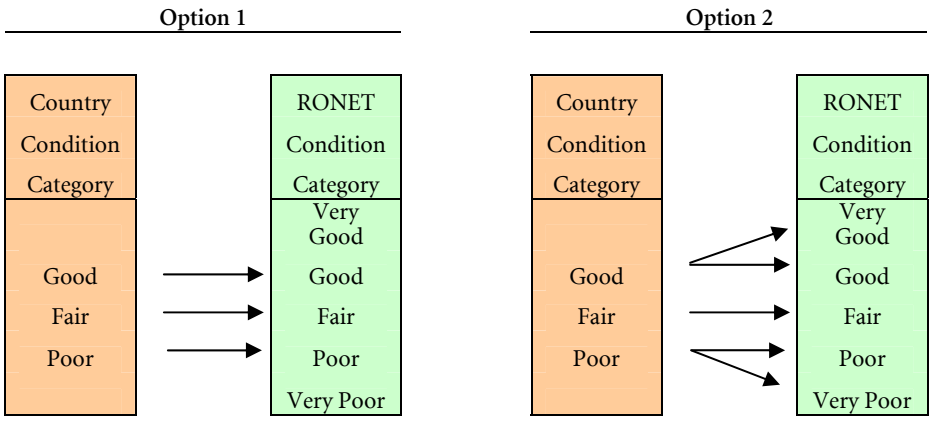
Secondary
Gravel

Traffic (AADT) \ Condition (IRI)		Very Good 5	Good 7	Fair 11	Poor 16	Very Poor 20	Total
Traffic I	<30	7.0	56.0	393.0	631.0	503.0	1,590.0
Traffic II	30-100	11.0	15.0	53.0	507.0	618.0	1,204.0
Traffic III	100-300	0.0	0.0	0.0	37.0	14.0	51.0
Traffic IV	300-1000	0.0	0.0	0.0	0.0	0.0	0.0
Traffic V	>1000	0.0	0.0	0.0	0.0	0.0	0.0
Total		18.0	71.0	446.0	1,175.0	1,135.0	2,845.0

The default values are values for a *fictitious country;* therefore, you must change them.

RONET defines five road condition categories (Very Good, Good, Fair, Poor, and Very Poor), but in some countries roads are classified in only three or four condition categories. You will have to judge how best to define the network on RONET, based on the network data you have available. For example, if you have only three categories (Good, Fair, and Poor), you can consider the following options: (i) assign 100 percent of the road in Good, Fair, and Poor condition to the corresponding RONET Good, Fair, and Poor condition categories and leave the RONET Very Good and Very Poor categories blank, or (ii) assign a percentage of the roads in Good condition to the RONET Very Good condition category, and the remaining percentage of the roads in Good condition to the RONET Good condition category; assign 100 percent of the roads in Fair condition to the corresponding RONET Fair condition category; assign a percentage of the roads in Poor condition to the RONET Poor condition category; and the remaining percentage of the roads in Poor condition to the RONET Very Poor condition category (recommended option). The options are outlined in figure 3.

Figure 3. Options for Assigning Road Condition Categories



100% in Good to Good
100% in Fair to Fair
100% in Poor to Poor

x% in Good to Very Good
100 - x% in Good to Good
100% in Fair to Fair
100 - x% in Poor to Poor
x% in Poor to Very Poor

The network length distribution can be originated from (i) aggregating the outputs of a Pavement Management System (PMS) or Road Database that presents for each homogeneous road section the section length, network type, surface type, traffic category, and condition category, if needed, transforming the outputs of the PMS to the units of RONET; or (ii) an engineering estimate of the network length distribution, based on secondary information and good judgment. Most likely, for primary and secondary roads, a PMS or a Road Database is available or is under development; therefore, an effort should be made to collect the network data from these sources of information. Most likely, for tertiary roads, unclassified roads, and urban roads, engineering estimates will be needed.

LENGTH & UTILIZATION

This output page presents the total network length (km) and total network utilization (million vehicle-km) and the distribution by network type, surface type, surface class (paved or unpaved), road condition category, and traffic category. At the top of the page, there is a table of contents where you can select among:

- Distribution by Network Type
- Distribution by Surface Type
- Distribution by Surface Class

Once you select an option, you can view the corresponding distribution by surface type, road condition and traffic categories. The network length tables are located on the right side and the utilization tables on the left. To return to the table of contents, press the T hyperlinks ("T" for Top) located on column B, or use the Excel features to go to the top of the page.

The network length values are computed by just summarizing the network length input data. The network utilization values are computed by multiplying, for each road class, the road class length times the average daily traffic of the road class. We have the following.

Utilization in Million vehicle-km = Length (km) X Average Daily Traffic (vehicles per day) x 365 (days) / 1,000,000

ASSET VALUE

This output page presents the total network maximum asset value (M $) and total network current asset value (M $), and the distribution by network type, road type, road condition category, and traffic category. At the top of the page, there is a table of contents where you can select among:

- Distribution by Network Type
- Distribution by Surface Type
- Distribution by Surface Class

Once you select an option, you can view the corresponding distribution by surface type, road condition category, and traffic category. The maximum asset value tables are located on the right side and the current asset value tables at the left. To return to the table of contents, press the T hyperlinks located on column B, or use the Excel features to go to the top of the page.

The asset value computed by RONET refers mostly to the asset value of the pavement. The maximum asset value is computed by multiplying, for each road class, the road class length times the new construction unit cost of the corresponding surface type, which was entered at the Country Data page. We have the following.

Maximum Asset Value in Million $ = Length (km) x New Construction Unit Cost ($/km)/1,000,000

The current asset value is computed by multiplying, for each road class, the road class length times the current asset value unit costs, which is a defined function of the surface type and current road condition as given in table 20.

Table 20. Asset Value by Surface Type and Current Road Condition

Road Type	Current Condition	Current Asset Value Unit Cost
Paved Roads	Very Good	Construction Unit Cost
	Good	Construction Unit Cost - Preventive Treatment Unit Cost
	Fair	Construction Unit Cost - Resurfacing Unit Cost
	Poor	Construction Unit Cost - Strengthening Unit Cost
	Very Poor	Construction Unit Cost - Full Reconstruction Unit Cost
Gravel Roads	Very Good	Construction Unit Cost
	Good	Construction Unit Cost - Spot Regraveling Unit Cost
	Fair	Construction Unit Cost - Regraveling Unit Cost
	Poor	Construction Unit Cost - Partial Reconstruction Unit Cost
	Very Poor	Construction Unit Cost - Full Reconstruction Unit Cost
Earth Roads	Very Good	Construction Unit Cost
	Good	Construction Unit Cost - Spot Repairs Unit Cost
	Fair	Construction Unit Cost - Heavy Grading Unit Cost
	Poor	Construction Unit Cost - Partial Reconstruction Unit Cost
	Very Poor	Construction Unit Cost - Full Reconstruction Unit Cost

We have the following:

Current Asset Value in Million $ = Length (km) X Current Asset Value Unit Cost ($/km) /1,000,000.

ROUGHNESS

This output page presents the network average roughness weighted by km (IRI, m/km) and network average roughness weighted by vehicle-km (IRI, m/km) by network type, surface type, road condition category, and traffic category. At the top of the page, there is a table of contents where you can select among:

- Roughness by Network Type
- Roughness by Surface Type
- Roughness by Surface Class

Once you select an option, you can view the corresponding roughness by surface type, road condition category, and traffic category. The average roughness tables weighted by km are located on the right and the average roughness tables weighted by vehicle-km tables are on the left. To return to the table of contents, press the T hyperlinks located on column B, or use the Excel features to go to the top of the page.

The network average roughness is computed by assigning to each road class the user- defined average roughness of the road class that was entered at the Basic Configuration page. The roughness values of each road class are weighted either by the road class length (km), or by the road class utilization (vehi-

cle-km) computed by multiplying the road class length by the average traffic of the road class defined at the Basic Configuration page.

NETWORK DISTRIBUTION CHARTS

This output page presents network distribution charts of the network length, utilization, and maximum and current asset value by network type and surface type. The charts are produced from the results presented on the previous output pages.

NETWORK MONITORING INDICATORS

This page presents a road network monitoring indicators table and two user-defined charts. The road network monitoring indicators table presents monitoring indicators by network type, subdivided into the following categories.

- Network Length
- Network Density
- Network Condition
- Network Access
- Network Standards
- Network Utilization
- Network Safety
- Network Asset

You define the two charts to be presented below the network monitoring indicators table. Select the two indicators to chart using the drop-down lists on cells B83 and B85, which have a yellow background.

Figure 4 shows the network monitoring indicators computed by RONET. The network access indicator "All-weather roads area of influence (4 km wide) per land area" is a rough proxy of the international Rural Access Indicator that measures the number of rural people who live within two kilometers (typically equivalent to a walk of 20-25 minutes) of an all-season road as a proportion of the total rural population [9].

Figure 4. Network Monitoring Indicators Computed by RONET

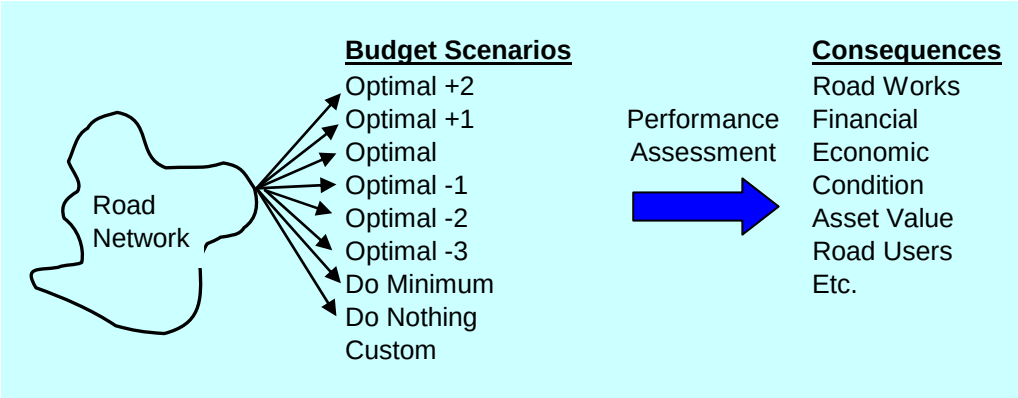
Network Monitoring Indicators	
Monitoring Indicator	
Network length	
Road network length	km
Road network length that is unpaved	km
Road network length that is paved	km
Road network length that is paved	%
Network Density	
Road network per thousand land area	km/1000 sq km
Road network per thousand total population	km/1000 persons
Road network per thousand rural population	km/1000 persons
Road network per thousand vehicles	km/1000 vehicles
Road network per $ million GDP	km/million $
Paved road network per thousand land area	km/1000 sq km
Paved road network per thousand total population	km/1000 persons
Paved road network per thousand rural population	km/1000 persons
Paved road network per thousand vehicles	km/1000 vehicles
Paved road network per $ million GDP	km/million $
Network Condition	
Percentage of road network in good and fair condition	%
Percentage of unpaved road network in good and fair condition	%
Percentage of paved road network in good and fair condition	%
Percentage of paved road network with roughness 4 m/km IRI or less	%
Paved roads average roughness weighted by km	IRI, m/km
Paved roads average roughness weighted by vehicle-km	IRI, m/km
Network Access	
Percentage of unpaved roads that are all-weather roads	%
All-weather roads area of influence (4 km wide) per land area	%
Network Standards	
Percentage of unpaved roads with 30 AADT or less	%
Percentage of unpaved roads with 300 AADT or more	%
Percentage of paved roads with 300 AADT or less	%
Percentage of paved roads with 10,000 AADT or more	%
Network Utilization	
Annual motorized vehicle utilization	million vehicle-km
Annual freight carried over road network	million ton-km
Annual passengers carried over road network	million ton-km
Average network annual average daily traffic	vehicles/day
Network Safety	
Annual number of fatalities	persons
Annual number of serious injuries	persons
Annual number of casualties	persons
Annual casualties cost	million $
Annual casualties cost as a share of GDP	%
Annual number of fatalities per total population	#/1000,000 persons
Network Asset	
Current Road asset value	million $
Current Road asset value as a share of maximum road asset value	%
Current Road asset value as a share of GDP	%

Part C — Performance Assessment Module

PERFORMANCE ASSESSMENT OVERVIEW

The objective of this module is to assess the consequences of different road works budget scenarios that represent different levels of road works expenditures over time, that for example are labeled Optimal +2, Optimal +1, Optimal, Optimal -1, Optimal -2, Optimal -3, Do Minimum, Do Nothing, and Custom. The consequences are presented on the road works requirements, financial cost, road condition, asset value, and so on. Figure 5 illustrates the process.

Figure 5. Consequences of Different Road Works Budget Scenarios



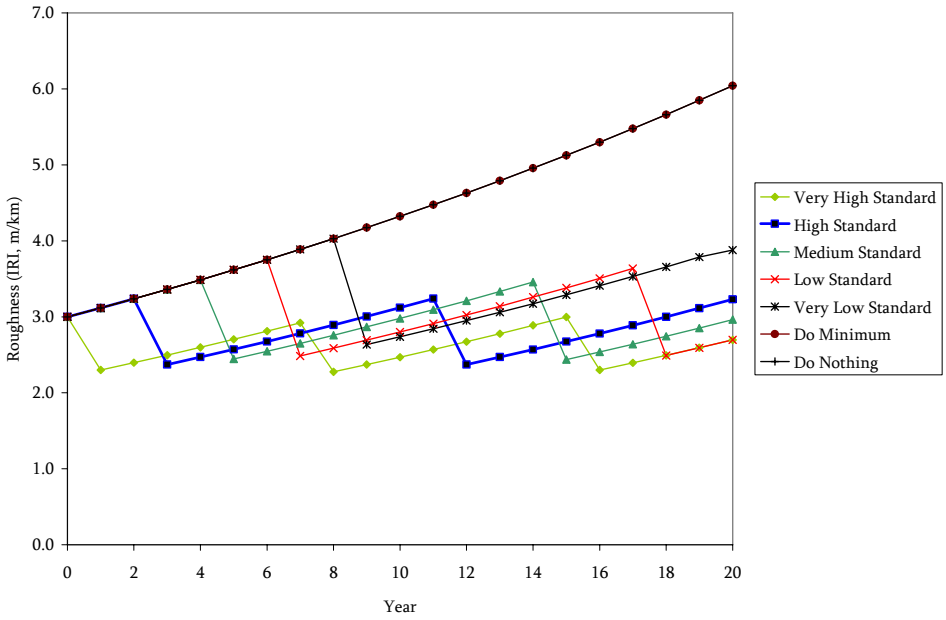
This module evaluates first the performance of each road class of the network under different road works standards over a 20-year evaluation period. The user-defined road works standards are the following:

- Very High Standard
- High Standard
- Medium Standard
- Low Standard
- Very Low Standard
- Do Minimum
- Do Nothing

The very high standard represents a policy without budget constraints and with a high frequency of periodic maintenance and rehabilitation works. The high, medium, low and very low standards represent cases of decreasing levels of frequencies of road works and corresponding annualized road works expenditures. The "do minimum" standard represents a policy where the only capital road work applied over the evaluation period is reconstruction at a very high roughness. The "do nothing" standard represents a policy where no capital road works are applied over the evaluation period. Figure 6 presents, for example, the roughness progression of a road with 3.0 IRI, m/km and a given traffic, under different standards. In this case, (i) the road requires three overlays during the evaluation period un-

der the very high standard (years 1, 7 and 15); (ii) the road requires one overlay in year 7 under the very low standard; and (iii) the "do-minimum" and "do-nothing" standards are equal and don't execute any capital road work during the evaluation period because the road does not reached a roughness level that merits reconstruction under the "do-minimum" standard.

Figure 6. Road Deterioration under Different Standards (level of service)



Once the performance of each road class is evaluated under the different standards, RONET presents the corresponding results for a series of budget scenarios that are defined in one of the following three possible evaluation options defined by the user:

- Evaluation of Optimal Standard per Road Class
- Evaluation of Custom Budged Scenario
- Evaluation of Applying same Standard on all Road Classes

Evaluation of Optimal Standard per Road Class

In this evaluation option, for each road class, RONET evaluates the performance of the road class under the different standards and calculates the corresponding stream of road agency costs (rehabilitation and maintenance), road user costs and total society costs (sum of road agency and user costs) over the evaluation period. RONET them computes the present value of the total society costs for each standard, at the input discount rate, and determines the optimal standard for the road class, which is the one that yields the lowest present value of total society costs.

The Optimal budget scenario represents a scenario of applying the optimal standard of each road class on all the road classes that comprise the network. Once RONET determines the optimal scenario, RONET defines the other budget scenarios as following:

- Optimal +1: for each road class RONET applies, if possible, a standard that is one level higher than the optimal standard in terms of road agency expenditures. Some example: (i) if the optimal standard is Medium Standard then RONET applies High Standard; (ii) if the optimal standard is Low Standard then RONET applies Medium Standard; and (ii) if the optimal standard is Very High Standard then RONET applies Very High Standard because that is the upper limit.
- Optimal +2: for each road class RONET applies, if possible, a standard that is two levels higher than the optimal standard in terms of road agency expenditures. For example, if the optimal standard is Medium Standard then RONET applies Very High Standard.
- Optimal -1: for each road class RONET applies, if possible, a standard that is one level lower than the optimal standard in terms of road agency expenditures. For example, if the optimal standard is Medium Standard then RONET applies Low Standard.
- Optimal -2: for each road class RONET applies, if possible, a standard that is two levels lower than the optimal standard in terms of road agency expenditures. For example, if the optimal standard is Medium Standard then RONET applies Very Low Standard.
- Optimal -3: for each road class RONET applies, if possible, a standard that is three levels lower than the optimal standard in terms of road agency expenditures. For example, if the optimal standard is Medium Standard then RONET applies Do Minimum Standard. Note that the lower limit is defined to be to apply the Do Minimum Standard and not the Do Nothing Standard.
- Do Minimum: RONET applies the Do Minimum Standard on all road classes
- Do Nothing: RONET applies the Do Nothing Standard on all road classes
- Custom: The user defines which standard to apply on each road class as a function of the network type and traffic category of the road class.
- The Optimal -1, Optimal -2, Optimal -3, Do Minimum and Do Nothing budget scenarios represent network budget constrains, while Optimal +1 and Optimal +2 represent scenarios of over spending in relation to the optimal scenario included on RONET to show the consequences of over spending resources..

Evaluation of Custom Standard per Road Class

In this evaluation option, the user defines a Custom Budget Scenario by defining one standard to be applied to each road class per network type and traffic level. RONET defines the other budget scenarios as following:

- Custom +1: for each road class RONET applies, if possible, a standard that is one level higher than the custom standard in terms of road agency expenditures.
- Custom +2: for each road class RONET applies, if possible, a standard that is two levels higher than the custom standard in terms of road agency expenditures.
- Custom -1: for each road class RONET applies, if possible, a standard that is one level lower than the custom standard in terms of road agency expenditures.

- Custom -2: for each road class RONET applies, if possible, a standard that is two levels lower than the custom standard in terms of road agency expenditures.
- Custom -3: for each road class RONET applies, if possible, a standard that is three levels lower than the optimal standard in terms of road agency expenditures.
- Do Minimum: RONET applies the Do Minimum Standard on all road classes
- Do Nothing: RONET applies the Do Nothing Standard on all road classes

Evaluation of Applying Same Standard on all Road Classes

In this evaluation option, RONET defines the budget scenarios as:

- Very High: RONET applies the very high standard on all road classes
- High: RONET applies the high standard on all road classes
- Medium: RONET applies the medium standard on all road classes
- Low: RONET applies the low standard on all road classes
- Very Low: RONET applies the very low standard on all road classes
- Do Minimum: RONET applies the Do Minimum Standard on all road classes
- Do Nothing: RONET applies the Do Nothing Standard on all road classes
- Custom: The user defines which standard to apply on each road class as a function of the network type and traffic category of the road class.

Performance Assessment Outputs

The outputs of this module are the following.

- Network Performance: presents the consequences to the total, paved or unpaved network of applying the different budget scenarios (road expenditure levels). Consequences are presented in terms of:
    - Road Agency Costs
    - Society Costs
    - Road Users Costs
    - Network Asset Value
    - Network Roughness
    - Network Condition
    - Annual Road Agency Costs
    - Annual Road Agency Costs by GDP
- Annual Work Program: presents for the total, paved or unpaved network and for a user-selected budget scenario, the stream of society costs, net benefits, road works, asset value, and network condition.

- Solution Catalog: presents for a user-selected budget scenario, the standards that will be applied on each road class.
- Road Works Distribution: presents, for a user-selected budget scenario, the distribution of the recurrent maintenance, periodic maintenance and rehabilitation costs, and road works length by network type, management type, surface type, and surface class, for years 1 to 5, 6 to 20 and 1 to 20. The output tables present: (i) total road works costs (M$); (ii) annual road works costs (M$/year); (iii) annual road works costs per km ($/km-year); (iv) costs per vehicle-km ($/vehicle-km) and (v) annual road works length (km/year).
- Road Works Summary: presents for a user-selected budget scenario, period (years 1 to 5, 6 to 20 or 1 to 20), and road work type (recurrent maintenance, periodic maintenance, rehabilitation, or all works), a summary of the distribution, by network type, management type and surface type, of the following: (i) road works costs; (ii) current network length, (iii) current network utilization; and (iv) current network asset value. This output page also presents a table with affordability indicators.
- Historical Expenditures Comparison: presents, for a user-selected budget scenario, each network type and road work type: (i) the historic expenditures over the last five years, (ii) the required expenditures over the next five years, and (iii) the ratio between the required per historic expenditures.

All the results are computed using Excel macros; therefore, you have to press the button "Performance Assessment" located at the main menu to compute the results. The results *are not* recomputed automatically when you change any configuration data or input data. When you press the button "Performance Assessment," RONET asks if you want to keep the intermediate results of the calculations in a temporary workbook. If you select Yes, all the intermediate results are stored in a new workbook that is created every time you select Yes at this option. The new workbooks are named "Book1," "Book2," "Book3," and so on. Once you have reviewed one of the temporary workbooks, you can close it or save it if necessary (saving with a different name if necessary). If you select No, then no temporary workbook is created. To compute the results can take between 2 and 5 minutes, depending on the computer processing speed. The status of the calculations is presented on the Excel status line at the bottom left corner of the screen. When all the calculations are done, the model presents a message indicating the end of the calculations and the duration of the calculations.

The characteristics of the road works standards are country-specific; therefore, you define the characteristics of the road works standards at the Standards Configuration page.

STANDARDS CONFIGURATION

The Standards Configuration page defines the characteristics of the road work standards to be evaluated at the Performance Assessment Module, which estimates the road deterioration of each road class under seven possible standards (Very High, High, Medium, Low, Very Low, Do Minimum and Do Nothing). The inputs on this page do not affect the results of the current condition assessment module. On this page, you configure the following.

- Custom Budget Scenario
- Budget Scenarios Evaluation Option
- Capital Road Works Standards
- Recurrent Maintenance Works Standards

Custom Budget Scenario

The custom budget scenario definition table is used to define the custom scenario to be evaluated. On this table, you define for each network type and traffic category the road work standard that will be applied under this custom scenario. For example, one can define to apply the very high standard on Motorways and Primary roads with high traffic and the low standard on Tertiary and Unclassified roads with low traffic. The custom scenario summarizes the overall results of applying the selected standards on the corresponding network types and traffic categories. The default values are given in table 21. These are country- or study-specific values; therefore, it is expected that you will change these values.

Table 21. Custom Budget Scenario Definition

Custom Budget Scenario Standards

		Traffic Category				
Code	Network Type	Traffic I	Traffic II	Traffic III	Traffic IV	Traffic V
H	Motorways	Very Low Standard	Low Standard	Medium Standard	High Standard	Very High Standard
I	Primary	Very Low Standard	Low Standard	Medium Standard	High Standard	Very High Standard
J	Secondary	Very Low Standard	Low Standard	Medium Standard	High Standard	Very High Standard
K	Tertiary	Very Low Standard	Low Standard	Medium Standard	High Standard	Very High Standard
L	Unclassified	Very Low Standard	Low Standard	Medium Standard	High Standard	Very High Standard

Budget Scenarios Evaluation Option

Here you define your choice for the definition of the budget scenarios to be the evaluated by RONET. You select an evaluation option by selecting one of the available option buttons as shown on Table 22.

Table 22. Budget Scenarios Evaluation Option

Budget Scenarios Evaluation Option

- (●) Evaluation of optimal standard per road class (lowest total society costs and highest NPV)
- ( ) Evaluation of custom standard per road class (user-defined standard)
- ( ) Evaluation of applying same standard on all road classes

Capital Road Works Standards Configuration

This table defines the capital road works (periodic maintenance and rehabilitation works) to be applied on each standard to be evaluated. The default values for concrete and asphalt concrete roads are given below in table 23. Most likely these default values are applicable for most countries worldwide; therefore, it is expected that few users will modify these default values.

Table 23. Cement Concrete and Asphalt Mix Roads Default Values

Roughness Thresholds to Apply Recommended Road Works (IRI, m/km)

Scenario		Roughness Range and Required Road Work				
		IRI<=4.0 Overlay	4.0<IRI<=6.0 Overlay	6.0<IRI<=8.0 Strengthening	8.0<IRI<=10.0 Reconstruction	10<IRI Reconstruction
Code	Name	Roughness Threshold (IRI)				
A	Very High Standard	3.00	4.00	6.00	8.00	10.00
B	High Standard	3.25	4.50	6.50	8.50	10.50
C	Medium Standard	3.50	5.00	7.00	9.00	11.00
D	Low Standard	3.75	5.50	7.50	9.50	11.50
E	Very Low Standard	4.00	6.00	8.00	10.00	12.00
F	Do Minimum	99.00	99.00	99.00	99.00	14.00
G	Do Nothing	99.00	99.00	99.00	99.00	99.00

On this table you define, for each roughness range, the roughness thresholds when the required capital road works will be applied. For example, for a road with current roughness of less than 4.0 IRI, on a very high standard scenario, the required overlay (periodic maintenance) will be applied when the road reaches 3.0 IRI; and on a very low standard scenario, when the road reaches 4.0 IRI. For roads with less than 6.0 IRI, the required road works are overlays; for roads between 6.0 and 8.0 IRI, the required road works are thick overlays (strengthening), and for roads with roughness higher than 8.0 IRI, the required road works are reconstructions. The default values for surface treatment roads are given in table 24. Most likely these default values are applicable for most countries worldwide; therefore, it is expected that few users will modify these default values.

Table 24. Default Values for Surface Treatment Roads

Time Interval and Roughness Thresholds to Apply Recommended Road Works (IRI, m/km)

Scenario		Roughness Range and Required Road Work				
		IRI<=4.0 Reseal	4.0<IRI<=7.0 Reseal	7.0<IRI<=9.0 Strengthening	9.0<IRI<=11.0 Reconstruction	11<IRI Reconstruction
Code	Name	Time Interval (years)		Roughness Threshold (IRI)		
A	Very High Standard	7	7	7.00	9.00	11.00
B	High Standard	9	9	7.50	9.50	11.50
C	Medium Standard	11	11	8.00	10.00	12.00
D	Low Standard	13	13	8.50	10.50	12.50
E	Very Low Standard	15	15	9.00	11.00	13.00
F	Do Minimum	99	99	99.00	99.00	15.00
G	Do Nothing	99	99	99.00	99.00	99.00

In this case, reseals are the work required for roads with roughness less than 7.0 IRI, and the reseals are scheduled at a fixed time interval in years. On this table, you define, for each roughness range, the roughness thresholds when the required capital road works will be applied for roads with roughness higher than 7.0 IRI, and the frequency of the reseals for roads with roughness less than 7.0 IRI. For example, for a road with current roughness less than 4.0 IRI, on a very high standard scenario, the required reseal (periodic maintenance) will be applied every seven years, and on a very low standard scenario, every 15 years.

RONET uses a simplified HDM-4 road deterioration equation to estimate the roughness progression over time as a function of the following road characteristics: (i) current roughness, (ii) road strength (modified structural number), (iii) pavement age, (iv) traffic loading (annual equivalent standard axles), and (v) environment coefficient (see annex 1). The capital road works are applied when the corresponding roughness or pavement age thresholds are reached.

The default values for gravel roads are given below in table 25. The left sub-table defines the regraveling postponement, in years, for each standard scenario. Most likely, these default values are applicable for most countries worldwide. The right sub-table defines the corresponding country specific average roughness of each standard scenario, and the bottom sub-table defines the average gravel characteristics, which are country-specific inputs.

Table 25. Default Values for Gravel Roads

Regraveling Postponement (years)

Scenario		Postponement
Code	Name	(years)
A	Very High Standard	0
B	High Standard	1
C	Medium Standard	2
D	Low Standard	3
E	Very Low Standard	4
F	Do Minimum	5
G	Do Nothing	999

Average Yearly Roughness Level (IRI, m/km)

Scenario		Roughness
Code	Name	(IRI)
A	Very High Standard	5
B	High Standard	7
C	Medium Standard	11
D	Low Standard	16
E	Very Low Standard	20
F	Do Minimum	22
G	Do Nothing	25

Gravel Characteristics

		Suggested Values for Different Gravel Types			
Characteristic	Value	Quartzitic	Lateritic	Coral	Volcanic
Gravel Plasticity Index (%)	10.1	9.1	10.1	13.0	17.0
Gravel Material Passing 0.075 mm Sieve (%)	25.5	24.2	25.5	25.0	23.5

Gravel Characteristics

		Suggested Values for Different Gravel Types			
Characteristic	Value	Quartzitic	Lateritic	Coral	Volcanic
Gravel Plasticity Index (%)	10.1	9.1	10.1	13.0	17.0
Gravel Material Passing 0.075 mm Sieve (%)	25.5	24.2	25.5	25.0	23.5

RONET uses the HDM-4 gravel loss deterioration equation to estimate the gravel loss over time as a function of the following road characteristics: (i) gravel characteristics, (ii) road geometry, (iii) road rainfall, and (iv) average daily traffic (see annex 2). On a very high standard scenario, the regraveling is applied when the gravel thickness reaches 50 mm (optimal case without budget constraints). On the other scenarios, the regraveling is applied after the user-defined years of postponement has elapsed after the regraveling year estimated for the very high standard. For example, if under the very high standard, the optimal year is year 6 (computed based on the HDM-4 equations), then under the very

low standard, the regraveling is applied on year 10 after the user-defined four years of postponement. The regraveling frequency and the recurrent maintenance determine the average roughness of gravel roads. On RONET, the average roughness of gravel roads for each standard is not computed using some equations; it is user-defined in the right sub-table.

The default values for earth roads are given below in table 26. The left sub-table defines the heavy grading interval, in years, for each standard scenario. Most likely, these default values are applicable for most countries worldwide. The right sub-table defines the corresponding average roughness of each standard scenario. These are country-specific inputs.

Table 26. Default Values for Earth Roads

Earth Roads Heavy Grading Interval (years)

Scenario		Interval
Code	Name	Years
A	Very High Standard	2
B	High Standard	4
C	Medium Standard	6
D	Low Standard	8
E	Very Low Standard	10
F	Do Minimum	12
G	Do Nothing	999

Average Yearly Roughness Level (IRI, m/km)

Scenario		Roughness
Code	Name	(IRI)
A	Very High Standard	7
B	High Standard	9
C	Medium Standard	13
D	Low Standard	18
E	Very Low Standard	22
F	Do Minimum	24
G	Do Nothing	25

RONET adopts the user-defined time interval of heavy grading to characterize each standard scenario. The interval of heavy grading and the recurrent maintenance determine the average roughness of earth roads. On RONET, the average roughness of earth roads for each standard is not computed using some equations; it is user-defined in the right sub-table.

Recurrent Maintenance Works Standards Configuration

Table 27 defines the recurrent maintenance works costs multipliers to be applied on each of the standards to be evaluated. The default values are given in table 26. Most likely these default values are applicable for most countries worldwide; therefore, it is expected that few users will modify these default values.

Table 27. Recurrent Maintenance Works Standards Configuration

Scenario		Surface Type				
Code	Name	Concrete	Asphalt	S.T.	Gravel	Earth
A	Very High Standard	1.00	1.00	1.00	1.00	1.00
B	High Standard	1.00	1.00	1.00	1.00	1.00
C	Medium Standard	1.00	1.00	1.00	1.00	1.00
D	Low Standard	0.50	0.50	0.50	0.50	0.50
E	Very Low Standard	0.50	0.50	0.50	0.50	0.50
F	Do Minimum	0.25	0.25	0.25	0.25	0.25
G	Do Nothing	0.00	0.00	0.00	0.00	0.00

On this table you define, for each surface type, the recurrent maintenance cost multipliers applicable to each standard scenario. For example, for the very high standard scenario, for asphalt roads, the recurrent maintenance costs defined at the Country Data page are multiplied by 1.00, whereas for the very low standard scenario, the recurrent maintenance costs defined at the Country Data page are multiplied by 0.50. Note that the average roughness of unpaved roads (defined before) is greatly related to the level of expenditures for recurrent maintenance of unpaved roads; therefore, you have to enter coherent values in both tables.

Paved Roads Deterioration Calibration Coefficients

This table allows for configuring the paved roads deterioration calibration coefficients for concrete, asphalt, and surface treatment roads. The a1 coefficient multiplies the modified structural number of the road, and the a2 coefficient multiplies the pavement age to replace the surface distress and rutting components of the roughness deterioration (see annex 1). It is expected that few users will modify these default values, and will do so only after performing an HDM-4 roughness progression calibration effort.

HISTORICAL EXPENDITURES

On this page you enter (i) the historical average road works expenditures during the last five years, in M$ per year, and (ii) the historical average road works during last five years, in km per year. You can enter this information by network type, road work type (rehabilitation, periodic maintenance, routine maintenance, and total), and surface class (paved, unpaved, and total). RONET computes on this page the corresponding average road works expenditures during the last five years, in $ per km, for the different road work types and surface classes.

The information entered into this page is used by the Performance Assessment Module to compare the required expenditure under different road work scenarios with the historical expenditures in the country.

NETWORK PERFORMANCE

This page presents the consequences of different budget scenarios (road expenditure levels). The consequences are presented in terms of:

- Road Agency Costs
- Society Costs
- Road Users Costs
- Network Asset Value
- Network Roughness
- Network Condition
- Annual Road Agency Costs
- Annual Road Agency Costs by GDP

On cell D1, you select, from the list of available choices, whether you want to view the consequences to the paved, unpaved, or total network. At the top of the page, there is a table of contents where you can select among:

- Total Society Costs and Net Benefits Charts
- Consequences to Road Agency
- Consequences to Society
- Consequences to Road Users
- Consequences to Network Asset Value and Network Roughness
- Consequences to Network Condition 1/2
- Consequences to Network Condition 2/2
- Consequences to Annual Road Agency Costs
- Consequences to Annual Road Agency Costs by GDP

Once you select an option, you can view the corresponding tables and charts. To return to the table of contents, press the T hyperlinks located on column B or use the Excel features to go to the top of the page.

The available tables and charts are the following:

- Total Society Costs and Net Benefits Charts
  - Chart of present value, at the defined discount rate, of road agency, road user, and total society costs
  - Chart o present value of net benefits compared with the present value of road agency costs
- Consequences to Road Agency
  - Road Agency Costs (Years 1-20)
  - Road Agency Costs Breakdown (Years 1-20)
  - Recurrent Maintenance as a Percent of Total Maintenance Costs
- Consequences to Society
  - Society Costs (Total Costs Years 1-20)
  - Society Net Loss Compared to Very High Standard (Total Costs Years 1-20)
  - Society Net Benefits Compared to Do Minimum Standard (Total Costs Years 1-20)
- Consequences to Road Users
  - Impact of Road Agency Deficit on Road User Costs
  - Unit Road User Costs
- Consequences to Network Asset Value and Network Roughness
  - Network Asset Value
  - Roughness Weighted by Km
  - Roughness Weighted by Vehicle-Km
- Consequences to Network Condition 1/2
  - Network Length in Very Good Condition
  - Network Length in Good Condition
  - Network Length in Fair Condition

- Consequences to Network Condition 2/2
  - Network Length in Poor Condition
  - Network Length in Very Poor Condition
  - Network Length by Road Condition (select the budget scenario for this table on cell D402)
- Consequences to Annual Road Agency Costs
  - Annual Road Agency Costs Years 1-5 (Annual Costs Years 1-5)
  - Annual Road Agency Costs Years 6-20 (Annual Costs Years 6-20)
  - Annual Road Agency Costs Years 1-20 (Annual Costs Years 1-20)
- Consequences to Annual Road Agency Costs by GDP
  - Annual Road Agency Costs Years 1-5 (Percentage of GDP)
  - Annual Road Agency Costs Years 6-20 (Percentage of GDP)
  - Annual Road Agency Costs Years 1-20 (Percentage of GDP)
- Consequences to Present Value Costs 1/2
  - Present Value of Road Agency Costs
  - Present Value of Society Costs
  - Present Value Society Net Loss Compared to Optimal Scenario
- Consequences to Present Value Costs 2/2
  - Present Value Society Net Benefits Compared to Do Minimum Standard (NPV)
  - Present Value Impact of Road Agency Deficit on Road User Costs

ANNUAL WORK PROGRAM

This page presents the annual work program for a user-selected budget scenario and road network. On cell C1, you select, from the list of available choices, a budget scenario. On cell E1, you select, from the list of available choices, whether you want to view the work program for the paved, unpaved, or total network. The output table presents the following annual values:

- Costs (million $)
  - Rehabilitation
  - Periodic Maintenance
  - Recurrent Maintenance
  - Road Agency
  - Road Users
  - Total Society
- Net Benefit Compared with Do Minimum Scenario (million $)
- Asset Value (million $)
- Annual Road Works (km)
  - Rehabilitation
  - Periodic Maintenance
  - Recurrent Maintenance
- Road Condition
  - Roughness Weighted per Km

- Roughness Weighted per Vehicle-Km

The output table also presents the totals in years 1-5, 6-20 and 1-20, annual values in these periods, and present values over the evaluation period, as well as the average network roughness over the evaluation period.

SOLUTION CATALOG

This page presents, for a user-selected budget scenario, the standards that RONET selected for each road class for the given budget scenario. On cell C1, you select, from the list of available choices, a budget scenario. Each standard is assigned a number that is presented on the solution catalog table.

ROAD WORKS DISTRIBUTION

This page presents, for a user-selected budget scenario, for the recurrent maintenance works, periodic maintenance works, rehabilitation works, and all works, the following information:

- Total road works costs (M$)
- Annual road works costs (M$/year)
- Annual road works costs per km ($/km-year)
- Road works per vehicle-km ($/vehicle-km)
- Annual road works length (km/year)

The information is presented by network type, management type, surface class and surface type, and for years 1 to 5, 6 to 20 and 1 to 20. On cell C1, you select, from the list of available choices, a budget scenario. At the top of the page, there is a table of contents where you can select among:

- Total Road Works Costs (M$) by Network Type and Surface Class
- Annual Road Works Costs (M$/year) by Network Type and Surface Class
- Annual Road Works Costs per Km ($/km-year) by Network Type and Surface Class
- Road Works per Vehicle-km ($/vehicle-km) by Network Type and Surface Class
- Annual Road Works Length (km/year) by Network Type and Surface Class
- Total Road Works Costs (M$) by Management Type and Surface Class
- Annual Road Works Costs (M$/year) by Management Type and Surface Class
- Annual Road Works Costs per Km ($/km-year) by Management Type and Surface Class
- Road Works per Vehicle-km ($/vehicle-km) by Management Type and Surface Class
- Annual Road Works Length (km/year) by Management Type and Surface Class
- Total Road Works Costs (M$) by Network Type and Surface Type
- Annual Road Works Costs (M$/year) by Network Type and Surface Type
- Annual Road Works Costs per Km ($/km-year) by Network Type and Surface Type

- Road Works per Vehicle-km ($/vehicle-km) by Network Type and Surface Type
- Annual Road Works Length (km/year) by Network Type and Surface Type
- Total Road Works Costs (M$) by Management Type and Surface Type
- Annual Road Works Costs (M$/year) by Management Type and Surface Type
- Annual Road Works Costs per Km ($/km-year) by Management Type and Surface Type
- Road Works per Vehicle-km ($/vehicle-km) by Management Type and Surface Type
- Annual Road Works Length (km/year) by Management Type and Surface Type

Once you select an option, you can view the corresponding tables. To return to the table of contents, press the T hyperlinks located on columns B or T, or use the Excel features to go to the top of the page.

ROAD WORKS SUMMARY

This page presents affordability indicators and a summary of the distribution of the network:

- Road works costs
- Current network length
- Current network utilization
- Current network asset value

The distribution is presented by network type, management type, and surface type.

On cell C1, you select, from the list of available choices, a budget scenario. On cell F1, you select a road works type (recurrent maintenance works, periodic maintenance works, rehabilitation works, capital works, or all works) and on cell I1 you select a period (year 1 to 5, 6 to 20 or 1 to 20). At the top of the page, there is a table of contents where you can select among:

- Affordability Indicators
- Information by Network Type
- Information by Surface Type
- Information by Management Type

Once you select an option, you can view the corresponding tables. To return to the table of contents, press the T hyperlinks located on column B, or use the Excel features to go to the top of the page.

HISTORICAL EXPENDITURES COMPARISON

This page presents, for a user-selected budget scenario, each network type and road work type: (i) the historic expenditures over the last five years, (ii) the required expenditures over the next five years, and (iii) the ratio between the required per historic expenditures. Similar tables are presented for the annual road works length, comparing the historical works, the required works and the ratio the required and historic works. On cell C1, you select, from the list of available choices, a budget scenario.

Part D – Road User Revenues Module

Road User Revenues Overview

The objective of this module is to estimate road user revenues collected from road user charges and to compare these revenues with the network funding requirements. Revenues computed are originated from fuel levies, new vehicle registration fees, license and inspection fees, insurance and other fees, load damage fees, distance travel fees, international transit revenues, tolls revenues, foreign vehicle permit revenues, vignettes revenues, carbon tax revenues, traffic enforcement revenues and other fees and taxes revenues. The funding requirements are defined for routine maintenance, periodic maintenance, rehabilitation, investments, administration and other expenditures. In other words, RONET determines the level of road user charges required to meet the funding requirements for a given budget scenario and the actual funding gap.

Vehicle Fleet Configuration

The Vehicle Fleet Configuration page defines the composition, utilization and fuel consumption characteristics of the vehicle fleet. The inputs on this page do not affect the results of the Current Condition Assessment or the Performance Assessment modules. The default values are given in table 28, which are country or study specific; therefore, it is expected that users will modify these default values.

Table 28. Vehicle Fleet Configuration

Vehicle Fleet Configuration

		Vehicle Fleet		Annual Utilization		Fuel Consumption			
							Annual Fuel Consumption		
Vehicle Type	Fuel Type (Diesel or Gasoline)	Country Fleet Composition (%)	Country Vehicle Fleet (veh)	Kilometers Driven per Year (km/yr)	Vehicle Utilization (million veh-km/yr)	Fuel Consumption (liters/ veh-km)	Diesel (million liters/yr)	Gasoline (million liters/yr)	Total (million liters/yr)
Motorcycle	G	0%	0	15,000	0	0.05	0	0	0
Car (Gasoline)	G	45%	45,000	25,000	1,125	0.12	0	135	135
Car (Diesel)	D	5%	5,000	25,000	125	0.12	15	0	15
Utility (Gasoline)	G	20%	20,000	35,000	700	0.12	0	84	84
Utility (Diesel)	D	5%	5,000	35,000	175	0.12	21	0	21
Truck Light	D	10%	10,000	35,000	350	0.15	53	0	53
Truck Medium	D	8%	8,000	50,000	400	0.23	92	0	92
Truck Heavy	D	2%	2,000	70,000	140	0.43	60	0	60
Truck Articulated	D	1%	1,000	80,000	80	0.64	51	0	51
Bus Light	D	1%	1,000	50,000	50	0.14	7	0	7
Bus Medium	D	2%	2,000	70,000	140	0.21	29	0	29
Bus Heavy	D	1%	1,000	80,000	80	0.29	23	0	23
Total		100%	100,000		3,365	0.17	352	219	571
			Annual fuel consumption (million gallons/yr)				93	58	151
			Annual fuel consumption (000 ton/yr)				299	164	463

New vehicles registered per year	10,000
Percent of trucks overloaded	10%

At the Country Data input page, you define the total number of vehicles in use in the country. At the Vehicle Fleet Configuration page, you define up to twelve vehicle types, the fuel type of each vehicle type (enter D for Diesel or G for Gasoline), the composition of the vehicle fleet, the kilometers driven per year, and the average unit fuel consumption, in liters/km. RONET computes the corresponding

total vehicle fleet utilization (million vehicle-km/year) and total annual diesel and gasoline fuel consumption, in million liters/year, million gallons/year and thousand tons per year. At this page, you also define the number of new vehicles registered each year and the percent of trucks that travel overloaded and should be subject to load damage fines.

The Vehicle Fleet Configuration page allows you to check if the network utilization computed at the Current Condition Assessment module, based on the distribution of the road network length by road classes, is consistent with the network utilization computed from the vehicle fleet data entered at the Vehicle Fleet Configuration page. A source of discrepancy could be the fact that the network being evaluated at the Current Condition Assessment module does not include urban streets and avenues, while the country vehicle fleet includes vehicles located in urban centers. Therefore, on this page you can enter your estimate for the urban centers vehicle utilization and compare the calculation of the total vehicle utilization from both methods. At this page, you can also check (i) if the total country fuel consumption entered in the Country data is consistent with the fuel consumption computed at this page; and (ii) if the fatalities computed at the current condition assessment monitoring indicators is consistent with the total country fatalities entered in the Country data. Table 29 show the tables used for checking these consistencies. You should modify your inputs either at the Road Network Length page and/or the Vehicle Fleet Configuration page until you obtain a satisfactory consistency.

Table 29. Check Utilization and Fuel Consumption Consistency

Check Vehicle Utilization Consistency

Utilization from Matrix of Road Classes

Motorways	0
Primary	1,694
Secondary	383
Tertiary	72
Unclassified	0
Total (million veh-km/yr)	2,149
Urban Streets & Avenues (million veh-km/yr)	1,000
Grand Total (million veh-km/yr)	3,149

Utilization from Vehicle Fleet Data

Total (million veh-km/yr)	3,365

Check Fuel Consumption Consistency

Consumption from Country Data

Diesel consumption (million liters)	350
Gasoline consumption (million liters)	210

Consumption from Vehicle Fleet Data

Diesel consumption (million liters)	352
Gasoline consumption (million liters)	219

Check Fatalities Consistency

Fatalities from Matrix of Road Classes

Motorways	
Primary	169
Secondary	38
Tertiary	7
Unclassified	
Total (persons/yr)	215

Fatalities from Country Data

Total country fatalities (persons/yr)	470

ROAD USER CHARGES

At this page you enter the road user charges that represent actual payments of road users. You have to enter the current road user charges broken down by type and assignment. Road user charges are composed of the following types:

- Diesel and gasoline levies (cents $/liter)
- Annual new vehicle registration fees ($/vehicle-year)
- Annual vehicle license and inspection fees ($/vehicle-year)
- Annual insurance and other fees ($/vehicle-year)
- Annual road damage fee ($/vehicle-year)
- Annual distance travel fee (cents $/km)
- International transit revenues ($/transit)
- Tolls revenues (cents $/km)
- Foreign vehicle permit revenues ($/vehicle-year)
- Vignettes revenues ($/vehicle-year)
- Carbon taxes revenues ($/vehicle-year)
- Traffic enforcement revenue ($/vehicle-year)
- Other fees and taxes revenues ($/vehicle-year)

Under this model framework, road user charges and taxes can be assigned to the road sector or assigned to the general budget. It is usually the Ministry of Finance or the treasury which is the initial recipient of the road user charges and they are then allocated to road funds, ministry of public works, urban road agencies, etc. depending on the local institutional set up and the legislation. You have the following options for road user charges assignment, as shown on Table 30:

- Assigned to the Road Sector
  - Road Fund
  - Urban Road Entities
  - Other Road Entities
- Assigned to general budget

Table 30. Road User Charges Assignment Sample

Road User Charges

Fuel Consumption

		Fuel Levy Assigned to the Road Sector				Taxes Assigned	Total
Revenue Source	Fuel Type	Road Fund (cent$/liter)	Urban Road Entities (cent$/liter)	Other Road Entities (cent$/liter)	Total Road Sector (cent$/liter)	to General Budget (cent$/liter)	Road User Charges (cent$/liter)
Fuel Consumption	Diesel	5.00			5.00	5.00	10.00
	Gasoline	5.00			5.00	15.00	20.00

Vehicle Fees

			Assigned to the Road Sector				Assigned	Total
Revenue Source	Vehicle Type	Number of Vehicles per Year (vehicles/year)	Road Fund ($/vehicle)	Urban Road Entities ($/vehicle)	Other Road Entities ($/vehicle)	Total Road Sector ($/vehicle)	General Budget ($/vehicle)	Road User Charges ($/vehicle)
Vehicle	Motorcycle	0		5.60		5.60		5.60
New Vehicle	Car (Gasoline)	4,500		22.00		22.00		22.00
Registration	Car (Diesel)	500		22.00		22.00		22.00
Fees	Utility (Gasoline)	2,000		33.00		33.00		33.00
	Utility (Diesel)	500		33.00		33.00		33.00
	Truck Light	1,000		33.00		33.00		33.00
	Truck Medium	800		72.00		72.00		72.00
	Truck Heavy	200		130.00		130.00		130.00

To compute the international transit revenues and the tolls revenues, you will also need to enter at this page the estimated annual number of transits and annual number of vehicle-kilometers travelled on toll roads per vehicle type.

Because a percentage of the road user charges revenues are used to cover the collection process costs, at this page, you also enter, for each road user charges source, the percent of revenues that represent the collection costs or fees, for example, for administration purposes, as shown on table 31. RONET computes and presents at the output pages, the effective road user charges revenues considering the reduction in the gross revenues due to the collection process.

Table 31. Road User Charges Lost During Collection Process

Percent of Gross Revenues Consumed During Collection Process

Revenue Source	Percent of Revenues (%)
Fuel Consumption	10%
New Vehicle & Registration Fees	10%
License & Inspection Fees	10%
Insurance & Other Vehicle Fees	10%
Road Damage Fees	10%
Distance Travel Fees	10%
International Transit Revenues	10%
Tolls Revenues	10%
Foreign Vehicle Permit Revenues	10%
Vignettes Revenues	10%
Carbon Taxes Revenues	10%
Traffic Enforcement Revenues	10%
Other Fees & and Taxes Revenues	10%

FUNDING REQUIREMENTS

At this page you define, per network type, the network annualized funding requirements in yeas 1 to 5, 6 to 10, or 1 to 20, which are composed of the following expenditures: (i) routine maintenance, (ii) periodic maintenance, (iii) rehabilitation, (iv) investments, and (v) administration and other. The routine maintenance, periodic maintenance and rehabilitation expenditures are the ones computed at the Performance Assessment module for a user-selected budget scenario. On cell B1, you select, from the list of available choices, the budget scenario, and on cell D1, you select, from the list of available choices, the budget period. The routine maintenance, periodic maintenance and rehabilitation expenditures are broken down for roads currently in stable condition (very good, good and fair condition) and road not in stable condition (poor and very poor roads). You have to enter your estimates of annualized investments, administration and other expenditures per network type, in million $/year, as shown on Table 32. There are two additional user-defined options for investment expenditures and three for administration and other expenditures.

Table 32. Annualized Funding Requirements

Optimal Scenario

Annualized Funding Requirements Years 1-5

		Motorways	Primary	Secondary	Tertiary	Unclassified	Total
Routine Maintenance	Very Good, Good and Fair Roads	0.00	1.56	1.89	0.17	0.00	3.61
	Poor and Very Poor Roads	0.00	0.64	1.95	1.50	0.00	4.08
	Subtotal (M$/year)	0.00	2.19	3.84	1.67	0.00	7.70
Periodic Maintenance	Very Good, Good and Fair Roads	0.00	12.03	2.07	0.10	0.00	14.20
	Poor and Very Poor Roads	0.00	0.21	2.32	2.85	0.00	5.37
	Subtotal (M$/year)	0.00	12.23	4.39	2.94	0.00	19.57
Rehabilitation	Very Good, Good and Fair Roads	0.00	0.06	2.40	0.92	0.00	3.38
	Poor and Very Poor Roads	0.00	15.27	23.51	21.58	0.00	60.37
	Subtotal (M$/year)	0.00	15.33	25.91	22.51	0.00	63.75
Investment Expenditures	New Construction (M$/year)						0.00
	Upgrading (M$/year)						0.00
	Widening (M$/year)						0.00
							0.00
							0.00
	Other (M$/year)						0.00
	Subtotal (M$/year)	0.00	0.00	0.00	0.00	0.00	0.00
Administration and Other Expenditures	Administration (M$/year)		1.00	1.00	1.00		3.00
	Road Safety (M$/year)						0.00
							0.00
							0.00
							0.00
	Other (M$/year)						0.00
	Subtotal (M$/year)	0.00	1.00	1.00	1.00	0.00	3.00
Total Expenditures	Total (M$/year)	0.00	30.76	35.14	28.12	0.00	94.01

Because not all funding requirements should necessarily be financed by road user charges, at this page, you also enter the percent of the funding requirements to be financed by road user charges as shown in Table 33. RONET computes at the bottom of the page, the resulting annualized funding requirements to be financed by road user charges (see Table 34).

Table 33. Annualized Funding Requirements

Percent of Funding Requirements to be Financed by Road User Charges

		Motorways	Primary	Secondary	Tertiary	Unclassified
Routine Maintenance	Very Good, Good and Fair Roads	100%	100%	100%	100%	100%
	Poor and Very Poor Roads	100%	100%	100%	100%	100%
Periodic Maintenance	Very Good, Good and Fair Roads	100%	100%	100%	100%	100%
	Poor and Very Poor Roads	100%	100%	100%	100%	100%
Rehabilitation	Very Good, Good and Fair Roads	100%	100%	100%	100%	100%
	Poor and Very Poor Roads	100%	100%	100%	100%	100%
Investment Expenditures	New Construction (M$/year)	100%	100%	100%	100%	100%
	Upgrading (M$/year)	100%	100%	100%	100%	100%
	Widening (M$/year)	100%	100%	100%	100%	100%
		100%	100%	100%	100%	100%
		100%	100%	100%	100%	100%
	Other (%)	100%	100%	100%	100%	100%
Administration and Other Expenditures	Administration (%)	100%	100%	100%	100%	100%
	Road Safety (%)	100%	100%	100%	100%	100%
		100%	100%	100%	100%	100%
		100%	100%	100%	100%	100%
		100%	100%	100%	100%	100%
	Other (%)	100%	100%	100%	100%	100%

Table 34. Annualized Funding Requirements to be Cover by Road User Charges

Annualized Funding Requirements Years 1-5 to be Financed by Road User Charges

		Motorways	Primary	Secondary	Tertiary	Unclassified	Total
Routine Maintenance	Very Good, Good and Fair Roads	0.00	1.56	1.89	0.17	0.00	3.61
	Poor and Very Poor Roads	0.00	0.64	1.95	1.50	0.00	4.08
	Subtotal (M$/year)	0.00	2.19	3.84	1.67	0.00	7.70
Periodic Maintenance	Very Good, Good and Fair Roads	0.00	12.03	2.07	0.10	0.00	14.20
	Poor and Very Poor Roads	0.00	0.21	2.32	2.85	0.00	5.37
	Subtotal (M$/year)	0.00	12.23	4.39	2.94	0.00	19.57
Rehabilitation	Very Good, Good and Fair Roads	0.00	0.06	2.40	0.92	0.00	3.38
	Poor and Very Poor Roads	0.00	15.27	23.51	21.58	0.00	60.37
	Subtotal (M$/year)	0.00	15.33	25.91	22.51	0.00	63.75
Investment Expenditures	New Construction (M$/year)	0.00	0.00	0.00	0.00	0.00	0.00
	Upgrading (M$/year)	0.00	0.00	0.00	0.00	0.00	0.00
	Widening (M$/year)	0.00	0.00	0.00	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00
	Other (M$/year)	0.00	0.00	0.00	0.00	0.00	0.00
	Subtotal (M$/year)	0.00	0.00	0.00	0.00	0.00	0.00
Administration and Other Expenditures	Administration (M$/year)	0.00	1.00	1.00	1.00	0.00	3.00
	Road Safety (M$/year)	0.00	0.00	0.00	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00
	Other (M$/year)	0.00	0.00	0.00	0.00	0.00	0.00
	Subtotal (M$/year)	0.00	1.00	1.00	1.00	0.00	3.00
Total Expenditures	Total (M$/year)	0.00	30.76	35.14	28.12	0.00	94.01

FUEL CONSUMPTION REVENUES

This page presents (i) the current effective fuel consumption revenues (gross revenues minus revenue lost during collection process), (ii) the fuel levy needed to finance the funding requirements, and (iii) a fuel levy revenues sensitivity table.

At the first table, RONET presents the current effective fuel consumption revenues by fuel type (diesel and gasoline) and by assignment (fuel levy assigned to the road fund, urban road entities or other entities and fuel taxes assigned to the general budget).

At the second table, RONET presents: (i) in one column the total annualized funding requirement to be financed by user charges, for the user-selected budget scenario and budget period, defined at the Funding Requirements input page, by type (routine maintenance, investments, etc.); and (ii) on the next column, the corresponding fuel levy required to finance the funding requirement, considering that the same fuel levy is applied to diesel and gasoline.

At the third table, RONET presents a sensitivity table that shows the revenues obtained from a fuel levy ranging from 1 to 60 cents $/liter, considering that the same fuel levy is applied to diesel and gasoline.

ROAD USER REVENUES

This page presents: (i) the unit road user charges, in cents/vehicle-km; (ii) the effective total road user revenues (gross revenues minus revenue lost during collection process), in $ million per year, by vehicle type and revenue source (fuel levy, tolls, etc.); (iii) the road user charges revenues distribution, in $ million per year, by revenue source and road user charges assignment (road fund, urban road entities,

etc.); and (iv) the road user charges revenues distribution, in percentage, for each road user charges assignment per revenue source.

Requirements and Revenues Comparison

This page presents: (i) the total annualized funding requirement to be financed by user charges, for a user-selected budget scenario and budget period, defined at the Funding Requirements input page, by type (routine maintenance, investments, etc.); (ii) the total effective road user revenues, which were computed on the Road User Revenues page, broken down by assignment (road fund, urban road entities, etc.); (iii) a comparison of road fund revenues and funding requirements, presenting the funding gap of the road fund; (iv) a comparison of total revenues and funding requirements, presenting the funding gap of the total road user charges revenues; and (v) two tables with road fund and total revenues indicators comparing them with the various funding requirements.

Annexes

ANNEX 1: PAVED ROADS ROUGHNESS PROGRESSION MODEL

An analysis of the HDM-4 roughness deterioration model for bituminous roads indicates that the deterioration of bituminous roads is a function of (i) current pavement strength taking into account current surface distress; (ii) equivalent standard axle loading; (iii) pavement age; (iv) environment coefficient; (v) roughness; (vi) increase during a year of rut depth standard deviation, cracking, and potholing; and (vii) deterioration factors. The RONET roughness progression model for paved road simplifies the HDM-4 model by (i) adopting the modified structural number at construction or last rehabilitation, to define the pavement strength by adding a strength reduction coefficient (a1) that multiplies the modified structural number to take into account the surface distress impact on the pavement strength; (ii) substituting the cracking, rutting, and potholing parameters of the HDM-4 model by a coefficient (a2) that multiplies the pavement age; (iii) considering that the K deterioration factors are equal to 1; and (iv) considering that pothole patching is always done on the roads. The simplified RONET model is given by the following equation:

$$dIRI = Kgp * (a0 * Exp (Kgm * m * AGE3) * [(1 + SNC * a1)]^{-5} * YE4 + a2 * AGE3) + (Kgm * m * RIa) \quad (1)$$

and

$$RIb = minimum (RIa + dRI, 16) \quad (2)$$

where

Kgp = 1, calibration factor of roughness progression

a0 = 134, which is the original a0 coefficient of the HDM-4 model

Kgm = 1, calibration factor for environmental coefficient

m = environmental coefficient (see table 2)

AGE3 = pavement age since last overlay, reconstruction or new construction (years)

SNC = modified structural number of pavement at construction, reconstruction, or last rehabilitation (modified structural number as defined on the HDM-III[7] documentation equal to the structural number computed following AASHTO guidelines, plus adding the strength contribution of sub-grade)

YE4 = annual number of equivalent standard axles (million ESA/lane/year)

RIa = roughness at the start of the analysis year (IRI, m/km)

RIb = roughness at the end of the analysis year (IRI, m/km)

dIRI = increment in roughness during one year

a1 = 0.7947, which is a coefficient derived on the RONET study to reflect the reduction of the strength of the pavement due to the presence of surface distress

a2 = 0.0054, which is a coefficient derived on the RONET study to reflect the increase in roughness progression of the pavement due to the presence of cracking, rutting, and potholes

The coefficients a1 and a2 and the K calibration coefficients can be configured at the Standard Configuration page.

RONET Roughness Progression Model Coefficients

The approach used to develop the RONET roughness progression model uses the full empirical simulation model of HDM-4 to generate roughness data for a wide range of the primary input data parameters, and estimates the parameters of the simple model by best fitting the generated data. Roughness data was generated for an array of the three primary variables (pavement strength, annual traffic loading, and environment) for the combinations shown on table A-1. Loading ranged from 10,000 to 1 million ESAL/lane-yr and strength from modified structural number 2 to 8. Three environments were considered with an m environmental coefficient of 0.025, 0.040, and 0.100, which correspond to different moisture and temperature classifications (see table 1A-2). All roads were considered to have an asphalt concrete surface, because the impact of the surface type classification (asphalt concrete or surface treatment) on the roughness progression is negligible. There were 48 possible combinations and a 20-year analysis period, resulting in a total of 960 observations.

Table 1A-1. Combinations of Primary Parameters Used to Generate Roughness Data

Environmental Factor	Structural Number	Thickness (mm)	Traffic Loading (million ESAL/year-lane)						
			0.01	0.03	0.10	0.20	0.30	0.50	1.00
0.025	2	30	X	X	X	X			
	3	50		X	X	X	X		
	5	80			X	X	X	X	
	8	100				X	X	X	X
0.040	2	30	X	X	X	X			
	3	50		X	X	X	X		
	5	80			X	X	X	X	
	8	100				X	X	X	X
0.100	2	30	X	X	X	X			
	3	50		X	X	X	X		
	5	80			X	X	X	X	
	8	100				X	X	X	X

Table 1A-2 presents the default HDM-4 m environmental coefficients for different moisture and temperature classifications, which are also given on Table 10.

Table 1A-2. m Environmental Coefficients

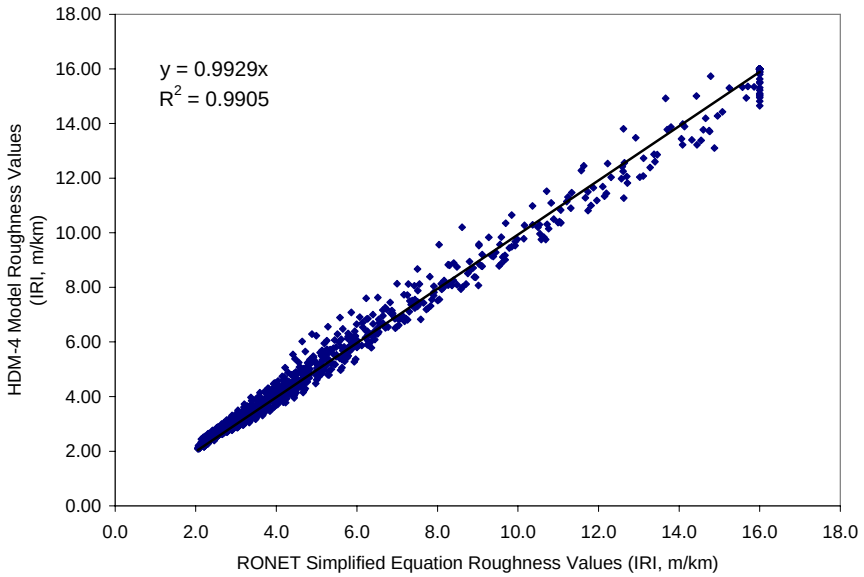
Moisture Classification	Temperature Classification				
	Tropical	Sub-tropical hot	Sub-tropical cool	Temperate cool	Temperate freeze
Arid	0.005	0.010	0.015	0.025	0.040
Semi-arid	0.010	0.015	0.025	0.035	0.060
Sub-humid	0.020	0.025	0.040	0.060	0.100
Humid	0.025	0.030	0.060	0.100	0.200
Per-humid	0.030	0.040	0.070		

The 960 observations of roughness at different years for the different road strength, loading, and environment classes, obtained by executing the HDM-4 model, were compared on an Excel workbook with the roughness progression results of the simplified RONET roughness progression model (equation 1) for different scenarios of coefficients a1 and a2. The Excel optimization routine was then used to find the optimal set of a1 and a2 coefficients that minimizes the sum of the square of the differences. The optimal a1 and a2 coefficients for equation 1 are as follows:

a1 = 0.7947
a2 = 0.0054

Figure 1A-1 below shows the comparison between the roughness values predicted by the HDM-4 model, and the roughness values predicted with the RONET model adopting the optimal a1 and a2 coefficients, which shows the good fit of the RONET model with an R2 of 0.99.

Figure 1A-1. RONET Simplified Equation Roughness Values (IRI, m/km)



The RONET paved roads deterioration equation 1 was derived evaluating the deterioration of bituminous roads. The same exercise was not done evaluating the deterioration of concrete roads; therefore, at the moment, RONET does not have road deterioration equations specific for concrete roads. To

roughly estimate the roughness progression of concrete roads using the current version of RONET, you will need to use equation 1 and define a pavement strength (modified structural number) representative of a concrete road.

ANNEX 2: GRAVEL ROADS GRAVEL LOSS MODEL

RONET estimates the material loss of gravel loss using the HDM-4 relationships for predicting the annual quantity of material loss as a function of monthly rainfall, traffic volume, road geometry, and characteristics of the gravel. The RONET model for gravel loss is given by the following equation:

$$MLA = Kgi * 365 * (3.46 + 2.46 * MMP * RF * 10^{-4} + KT * AADT) \quad (3)$$

Where

MLA = the predicted annual material loss (mm/year)

RF = average rise plus fall of the road (m/km)

MMP = mean monthly precipitation (mm/month)

AADT = annual average daily traffic (veh/day)

KT = the traffic-induced material whip-off coefficient

Kgi = gravel material loss calibration factor

The traffic-induced material whip-off coefficient is expressed as a function of rainfall, road geometry, and material characteristics, as follows:

$$KT = Kkt * \text{maximum } \{0 , (0.022 + (0.969 * C)/57300) + 3.42 * MMP * P075j * 10^{-6} – 9.2*MMP*PIj * 10^{-6} – 1.01 * MMP * 10^{-4})\} \quad (4)$$

Where

C = average horizontal curvature of the road (deg/km)

PIj = Plasticity index of material

P075j = Gravel material passing 0.075 mm sieve (%)

Kkt = traffic-induced material loss calibration factor

ANNEX 3: ROAD WORKS EFFECTS

RONET estimates the road works effects using the HDM-4 relationships that are given below.

Reseal

The roughness after a reseal is computed by the following equation.

$$RIaw = RIbw - \text{maximum}(0, \text{minimum}(0.3 * (RIbw - 5.4), 0.5)) \quad (5)$$

Where

RIaw = Roughness after reseal (IRI, m/km)

RIbw = Roughness before reseal (IRI, m/km)

The structural number after a reseal is computed by the following equation.

$$SNaw = SNbw + REth * 0.2 * 0.0394 \quad (6)$$

Where

SNaw = Structural number after reseal

SNbw = Structural number before reseal

REth = Reseal thickness (mm)

Overlay

The roughness after an overlay is computed by the following equation.

$$RIaw = 2.0 + 0.01 * \text{maximum}(0, (RIap - 2.0) * \text{maximum}(0, (80 - OVth)) \quad (7)$$

Where

RIaw = Roughness after overlay (IRI, m/km)

RIbw = Roughness before overlay (IRI, m/km)

OVth = Overlay thickness (mm)

The structural number after a reseal is computed by the following equation.

$$SNaw = SNbw + OVth * 0.4 * 0.0394 \quad (8)$$

SNaw = Structural number after overlay

SNbw = Structural number before overlay

Reconstruction

The roughness and the structural number of paved roads after a reconstruction is user defined at the Country Data page.

Gravel Thickness

The gravel thickness after regraveling is computed by the following equation.

$$GTaw = GTbw + GTth \quad (9)$$

Where

GTaw = Gravel thickness after regraveling (mm)

GTbw = Gravel thickness before regraveling (mm)

GTth = Regraveling thickness (mm)

ANNEX 4: IMPROVEMENTS TO RONET VERSION 1.01

These are the main improvements found in RONET Version 2.0:

a) The structure of this manual was changed to presents the three RONET modules in sequence.

b) A new module was added to evaluate road user revenues originated from road user charges and compare the road user revenues with the network funding requirements.

c) Default network types changed to Motorways, Primary, Secondary, Tertiary and Unclassified; changing Urban by Motorways.

d) At the main menu, deleted repeated input and configuration pages.

e) At the standards configuration, the custom scenario now is defined by selecting a standard per network type and traffic category, while on version 1.01 the only choice was selecting a standard by network type.

f) At the standards configuration, at the definition of the time interval and roughness thresholds to apply recommended road works for Surface Treatment roads, the roughness thresholds for strengthening and reconstruction have changed to 7.0, 9.0 and 11.0 IRI, m/km, from 6.0, 8.0 and 10.0 IRI, m/km, which are the thresholds for Asphalt Mix roads.

g) At the standards configuration, the default recurrent maintenance costs multipliers have been changed.

h) Added a vehicle fleet configuration page where you define up to twelve vehicle types, the vehicle fleet composition, vehicle fleet utilization per vehicle type and unit diesel and gasoline fuel consumption.

i) At the country data input page, the following country data was added: total road network length, total paved road network length, diesel annual fuel consumption, gasoline annual fuel consumption, total accidents fatalities, and total accidents serious injuries.

j) At the country data input page, the default unit costs for capital works and recurrent maintenance costs were updated to reflect developing countries representative values.

k) At the country data input page, to estimate accidents numbers and costs, fatality rates and serious injury rates were added, as well a multiplier to the GDP per capita to obtain the fatality costs to society and the injury costs as a percentage of the fatality cost.

l) The Historical Data input page was renamed to Historical Expenditures to not confuse with historical road condition data that is not utilized by RONET.

m) At the Monitoring Indicators output page, RONET is now presenting network safety indicators in terms of fatalities and serious injuries.

n) At the Monitoring Indicators output page, RONET is now presenting an indicator for road access that computes the all-weather roads area of influence (assuming a 4 km wide width multiplied by the road length) as a share of the Country land area.

o) At the Performance Assessment module, the results are now being presented per budget scenario and not per road work standard. There are three possible ways of defining the budget scenarios: (i) evaluate optimal standard (lower society costs) per road class and lower and higher budget scenarios; (ii) evaluate custom standard per road class and lower and higher budget scenarios; and (iii) evaluate all road classes with the same standard (similar to version 1.01). The choice is done at the standards configuration page.

p) At the Network Performance output page, two new charts are being presented at the top of the table: (i) the present value of road agency, road users, and total society costs for each budget scenario, and (ii) the present value of net benefits of each budget scenario against the present value of road agency costs.

q) The new Annual Work Program output page presents, for a user-defined budget scenario and network, annual values for: (i) road agency, road user and total society costs, (ii) net benefits compared to the Do Minimum scenario, (iii) asset value, (iv) road works length, and (v) average network roughness.

r) The new Solution Catalog output page presents, for a user-defined budget scenario, the standard that RONET selected for each road class for the given budget scenario.

s) At the Road Works Distribution output page, RONET is now calculating the Road Works Costs per Vehicle-Km ($/veh-km).

t) At the Road Works Summary output page, RONET is now presenting a table with affordability indicators.

u) The speed of the calculation of the performance assessment module was improved.

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