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**COURSEON THE ROAD NETWORK EVALUATION TOOLS: RONET**

**AdministraçãoNacional de Estradas (ANE)**

**Maputo, Mozambique, November 4-8, 2013**

***INTRODUCTION, OVERVIEW, INTERACTIVE EXERCISE, OPTIMIZATION***

***OF ROAD MAINTENANCE AND REHABILITATION***

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**A. INTRODUCTION**

The Road Network Evaluation Tools (RONET), developed by the Sub-Saharan Africa Transport Policy Program[[1]](#footnote-1) (SSATP), is designed to assess the current characteristics of road networks and their future performance depending on different level of interventions to the network.[[2]](#footnote-2) RONET includes three evaluation modules: (i) Current Condition Assessment Module, that computes network statistics and monitoring indicators; (ii) Performance Assessment Module, that estimates the network performance and budget requirements under different maintenance and rehabilitation standards; and (iii) Road User Revenues Module, that evaluates revenues collected from road user charges and compares them with the funding requirements. RONET is structured with many configuration options for use in developing countries.

The training material for this course is the result of an update and expansion of a workshop on the Road Network Evaluation Tools (RONET) held as a part of the 5th Africa T2 Conference, Tanzania, November, 2011,[[3]](#footnote-3) as well as intensive RONET training carried out in Cotonou, Benin, on June 18-22, 2012; Dakar, Senegal, on September 9-13, 2013; and Arusha, Tanzania, on June 25-29, 2012 and September 16-20, 2013.

**B. COURSE OVERVIEW**

The RONET training course includes:

a. An overview of the RONET model, including its main concepts and background, as well as input data and results provided (see Power Point presentation);

b. A RONET demonstration, which includes sample input data and typical output from the three evaluation modules of RONET, as well as a demonstration of HDM-4 Road Use Costs Model - RUCKS (which is required to run RONET);

c. A hands-on application of RONET, through an interactive numerical exercise, where the workshop participants will work in small teams; and

d. Optimization of road maintenance and rehabilitation for a road network in each participating country, where each country delegation will have an opportunity to run RONET using actual data from their country.

**C. INTERACTIVE RONET EXERCISE**

The exercise provides the participants an opportunity to work individually or in small teams to apply RONET to a hypothetical country. This will serve as preparation for the country delegations to run RONET for a road network in their own country. Please form small working teams; team members do not have to be from the same country.

Each working team will need the RONET software installed in its computer, as well as the Road User Costs Knowledge System (RUCKS) software, Version 1.2. Both programs can be downloaded free of charge from:

<http://go.worldbank.org/FF0CT8M770>

<http://www4.worldbank.org/afr/ssatp/tools-ronet.aspx>

Each team will receive a set of input data and will run the model to produce the optimum maintenance and rehabilitation strategy, and the budget required for such optimum strategy, for a road network located in a hypothetical country (henceforth called Farstania). The calculations will be performed over a 20-year analysis period. The results of the exercise will be discussed by all the participants, and comparisons will be made based on the different input data used by each team.

**C.1 DATA TO BE USED BY EACH WORKING TEAM**

**Basic Configuration**

Environmental type 11 (Sub-humid, Tropical)

Terrain type Hilly, Rise and Fall 30 m/km

Horizontal curvature 35 deg/km

**Country Data**

Country Name Farstania

Current Year 2013

Land Area (sq km) 200,000

Total Population (millions) 10

Rural Population (millions) 4

Total Road Network, 2-lane equivalent (km) 25,000

Paved Road Network, 2-lane equivalent (km) 6,600

**Road Network Two-lane Equivalent: Length, condition and traffic levels**

Road condition: Good 20%, Fair 50%, and Poor 30%

Primary road network: 5000 km, of which 30% asphalt mix, 70% surface treatment.

20% between 300 & 1000 vpd;

80% between 1000 & 3000 vpd

Secondary road network: 8000 km, 20% surface treatment, 80% gravel

40% between 300 & 1000 vpd

60% between 1000 & 3000 vpd

Tertiary road network: 12,000 km, 25% gravel; 75% earth

For gravel: 40% less than 30 vpd; 60% between 30 & 100 vpd

For earth: 45% less than 10 vpd; 55% between 10 & 30 vpd

**Vehicle Fleet Configuration**

Fuel type: G = Gasoline; D = Diesel

*Fleet*

*Composition*

*Vehicle Type Fuel (%)*

Motorcycle G 5.0%

Car Small G 20.0%

Car Medium G 20.0%

Delivery Vehicle G 10.0%

Four-Wheel Drive D 10.0%

Truck Light D 5.0%

Truck Medium D 10.0%

Truck Heavy D 10.0%

Truck Articulated D 5.0%

Bus Light D 1.0%

Bus Medium D 3.0%

Bus Heavy D 1.0%

**HDM4 Road Use Costs Model (RUCKS, v1.20)**

Vehicle fleet composition: same as above

Terrain type: Hilly, Rise and Fall 30 m/km; Horizontal curvature 35 deg/km

Altitude (m): 600

Speed Limit (km/h) 80

Fuel Price

Fuel price per working team ($/liter) Team 1 Team 2 Team 3

Gasoline 1.2 1.1 1

Diesel 1.1 1 0.9

Fuel price per working team ($/liter) Team 4 Team 5 Team 6

Gasoline 0.9 0.8 0.7

Diesel 0.8 0.7 0.6

Fuel price per working team ($/liter) Team 7 Team 8 Team 9

Gasoline 0.6 0.5 0.4

Diesel 0.5 0.4 0.3

Fuel price per working team ($/liter) Team 10

Gasoline 0.3

Diesel 0.2

**Default values: Please use the RONET and RUCKS default values for all other parameters**

RONET and RUCKS (v1.2) are available at:

<http://go.worldbank.org/FF0CT8M770>

**C.2 QUESTIONS FOR THE WORKING TEAMS**

1 What is the current asset value of the entire road network of Farstania?

2 Please estimate the current overall roughness (in terms of IRI, expressed in m/km) of Farstania’sroad network:

a. weighted by km

b. weighted by vehicle-km

3 For the optimum road maintenance and rehabilitation alternative, please calculate the Present Value of:

a. Agency cost

b. Road user cost

c. Total society cost

d. Net benefit

*NB: Please consider Years 1 to 20 (analysis period) and a 12% Discount Rate*

4 For the optimum road maintenance and rehabilitation scenario, please calculate

(a) The total cost of road works (i.e., road agency cost) for years 1 to 5;

(b) The net present value (at 12% discount rate) of the 20-year program; and

(c) The internal rate of return of the program.

5 Assuming a fuel levy of $0.10/liter in Farstania for both gasoline and diesel,

please calculate the average annual fuel tax revenues in the country.

6 Please estimate the minimum required fuel tax rate for the fuel tax revenues to cover the road agency expenditures (years 1 to 5 average) under the optimum scenario.

7 The input data used in this numerical example reflect the prevailing conditions

inFarstania. Please describe some of the required changes to the data so that the results would be more applicable to your country (or to the road network under your

responsibility).

**C.3HINTS TO ANSWER THE QUESTIONS**

1. Define the relationship between unit road user costs and roughness for Farstania, in the form of the following cubic polynomial:

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

The coefficients a0, a1, a2 and a3 can be calculated using the Road User Costs Knowledge System (RUCKS) version 1.2. Suggest (i) opening RUCKS, (ii) enabling macros, (iii) entering the relevant data provided under C.1, (iv) run the model, (v) the coefficients will be available under “Traffic Levels Roughness Sensitivity.”

1. Open RONET: RONET v2.00-MainModule-2009-01.xls
2. Enable macros
3. Enter the relevant data provided under C.1
4. Copy to “Country Data” the Unit Road User Costs coefficient matrix from RUCKS
5. Run RONET (press the PAM button) and wait for the results (usually more than 3 minutes)
6. Obtain from RONET Outputs the answers to the Team’s Questions:

Question 1 RONET “Asset Value” output

Question 2 RONET network “Roughness” output

Question 3 RONET “Network Performance” output: Total Society Costs at 12% Discount Rate (M$)

Question 4 RONET “Annual Work Program” output

Question 5 RONET “Fuel Consumption Revenues” output: “Fuel Levy Revenues Sensitivity”

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Question 6 Obtain the annual optimum expenditures from RONET “Annual Work Program” output. Then look for the tax rate in “Fuel Levy Revenues Sensitivity, under “Fuel Consumption Revenues,” RONET

Question 7 Summary of your team's discussions

**D. OPTIMIZATION OF MAINTENANCE AND REHABILITATION OF A ROAD NETWORK IN PARTICIPATING COUNTRIES**

For this exercise, the participants are asked to work in small teams (say three or four members per team). The main objective is to prepare an optimum road maintenance and rehabilitation program for a road network of particular interest for each team. The exercise will comprise:

1. Select a road network, for which you will define the optimum road maintenance and rehabilitation program for the next five years (using a 20-year analysis period)
2. Define the relationship between unit road user costs and roughness for your country, in the form of the following cubic polynomial:

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

The coefficients a0, a1, a2 and a3 can be calculated using Road User Costs Knowledge System (RUCKS) version 1.2. Suggested sequence: (i) open RUCKS, (ii) enable macros, (iii) enter the relevant RUCKS input data reflecting, to the extent possible, the prevailing conditions in your country, (iv) run the model, (v) the a0, a1, a2 and a3 coefficients will be available under “Traffic Levels Roughness Sensitivity”

1. Open RONET: RONET v2.00-MainModule-2009-01.xls
2. Enable macros
3. Enter the RONET input data for the selected road network, as well as other input data reflecting, to the extent possible, the prevailing conditions in your country
4. Copy to “Country Data” the Unit Road User Costs coefficient matrix from RUCKS
5. Run RONET (press the PAM button) and wait for the results (usually more than 3 minutes)
6. Check for consistency the fuel consumption calculated by RONET and the fuel consumption obtained from other sources and included in “Country Data.” In case of divergence, please adjust the data under “Vehicle Utilization” (number of km) so that the fuel consumption calculated by RONET is consistent with the fuel consumption included in “Country Data.”[[4]](#footnote-4)
7. Obtain from RONET Outputs the optimum road maintenance and rehabilitation program for the selected road network for the next five years
8. Prepare a brief report summarizing the optimum road maintenance and rehabilitation program, including (i) road works in the program, (ii) costs and benefits, including economic internal rate of return, (iii) consequences to road users if a less than optimum program has to be implemented , and (iv) the required fuel tax (on gasoline and diesel fuel) if the optimum program is to be financed solely by fuel tax
9. Make a brief presentation to all participants of your results and conclusions. The presentation is to be delivered by one or more representatives of each country

**E. TRAINING CLOSURE**

(a) Final discussions

(b) Closing of the training session

**F. PROPOSED SCHEDULE**

**Maputo, Mozambique, November 4-8, 2013**

November 4

9am-12 noon: Training opening; Introduction of participants; RONET overview

1:30 pm-4:30 pm: RONET demonstration; RUCKS demonstration

November 5

9am-12 noon: Interactive numerical exercise, begin teamwork

1:30 pm-4:30 pm: Interactive numerical exercise, solutions and presentation of results by teams

November 6

9am-12 noon: Optimization of road maintenance and rehabilitation (M&R) for a road network in each participating country: Country delegations select a road network for analysis and begin entering input data

1:30 pm-4:30 pm: Prepare optimum M&R program from RONET; Start report preparation

November 7

9am-12 noon: Country delegation work: continue preparation of report on the M&R optimum program for the selected network in each country

1:30 pm-4:30 pm: Completion of country reports

November 8

9am-12 noon: Presentation of the optimum M&R program by country delegations

1:30 pm-4:00 pm: Continuation of the presentations

4:00 pm-4:30 pm: Distribution of certificates to the participants. Training closure

**Appendixes**

1. HDM-4 default values for roughness

|  |  |  |  |
| --- | --- | --- | --- |
| Paved Roads Roughness (IRI, m/km) | | | |
| Road | Primary | Secondary | Tertiary |
| Condition | Roads | Roads | Roads |
| Good | 2 | 3 | 4 |
| Fair | 4 | 5 | 6 |
| Poor | 6 | 7 | 8 |
| Bad | 8 | 9 | 10 |

1. HDM-4 default values for road geometry parameters

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Number |  |  |  |  | Speed |  |  |
|  | Rise & | Rise & | Horizontal | Super\_ |  | Speed | Limit | Roadside | NMT |
| Road | Fall | Fall | Curvature | elevation | Altitude | Limit | Enforcement | Friction | Friction |
| Geometry | (m/km) | (#) | (deg/km) | (%) | (m) | (km/h) | (#) | (#) | (#) |
| Straight and level | 1 | 1 | 3 | 2.0 | 0 | 110 | 1.1 | 1.00 | 1.00 |
| Mostly straight and gently undulating | 10 | 2 | 15 | 2.5 | 0 | 100 | 1.1 | 1.00 | 1.00 |
| Bendy and generally level | 3 | 2 | 50 | 2.5 | 0 | 100 | 1.1 | 1.00 | 1.00 |
| Bendy and gently undulating | 15 | 2 | 75 | 3.0 | 0 | 80 | 1.1 | 1.00 | 1.00 |
| Bendy and severely undulating | 25 | 3 | 150 | 5.0 | 0 | 70 | 1.1 | 1.00 | 1.00 |
| Winding and gently undulating | 20 | 3 | 300 | 5.0 | 0 | 60 | 1.1 | 1.00 | 1.00 |
| Winding and severely undulating | 40 | 4 | 500 | 7.0 | 0 | 50 | 1.1 | 1.00 | 1.00 |

Sources: HDM-4 Volume 4 “Analytical Framework and Model Description” and HDM-4 Volume 5 “A Guide to Calibration and Adaptation.”

**CRONOGRAMA PARA CADA EQUIPE**

**Quinta feira, 7 Novembro:**

**Fazer todos os cálculos (RONET e RUCKS). Preparar a apresentação**

**Sexta feira, 8 Novembro:**

**Completar as apresentações ate as 9 am (Sugestão: 5 ou 6 slides por equipe)**

**Apresentações e discussões: A partir das 9 am**

1. SSATP home page: <http://www.worldbank.org/afr/ssatp> [↑](#footnote-ref-1)
2. For a complete RONET description please see RONET User’s Guide, by Rodrigo Archondo-Callao, available at <http://go.worldbank.org/FF0CT8M770> or <http://www.worldbank.org/afr/ssatp> [↑](#footnote-ref-2)
3. 5th Africa T2 Conference:<http://www.conference.tant2centre.or.tz/default.asp> [↑](#footnote-ref-3)
4. This procedure assumes that the fuel consumption under “Country Data” was obtained from reliable sources. [↑](#footnote-ref-4)