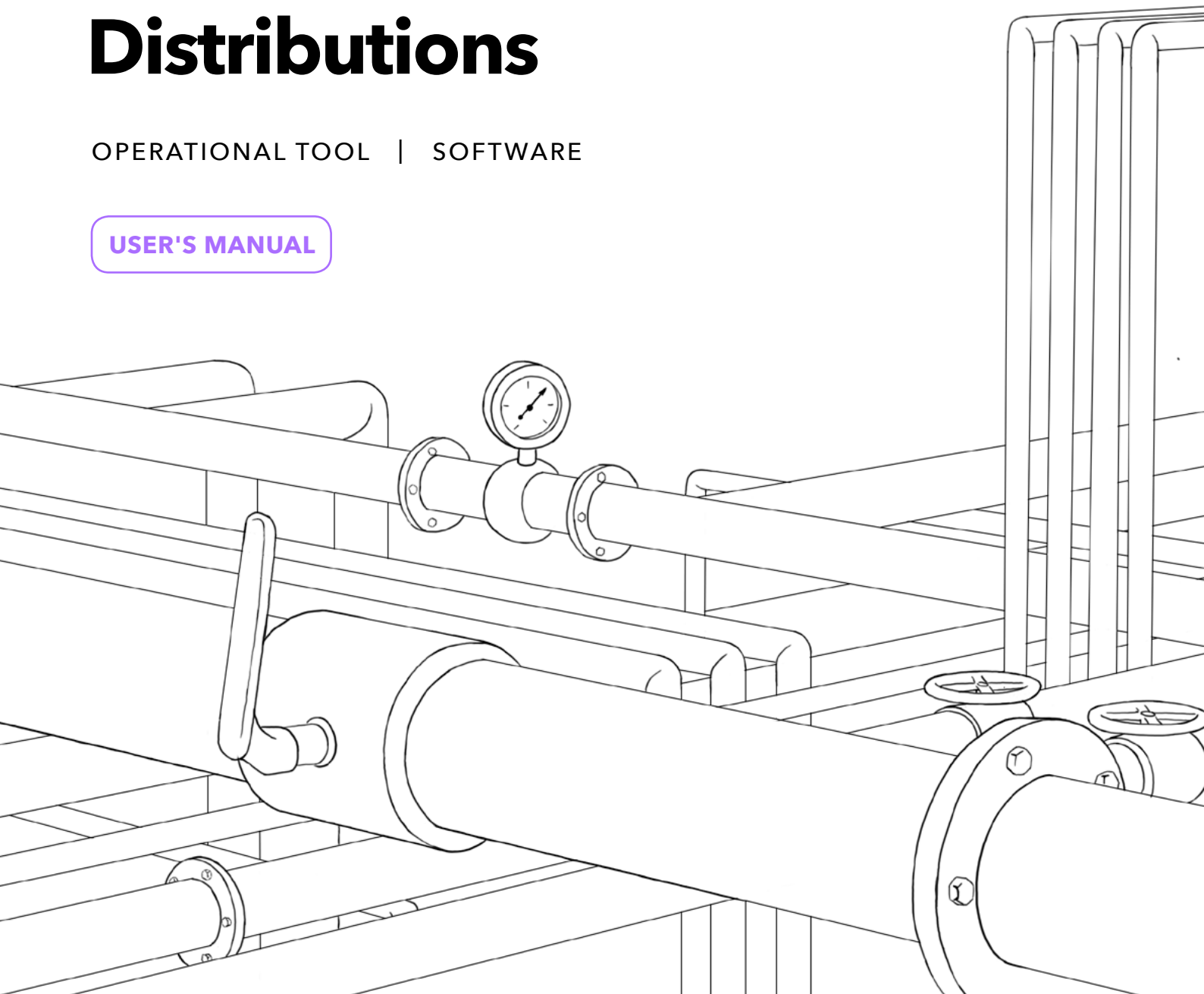


Risk-based Renewal Planning for Asset Management of Water Distributions

OPERATIONAL TOOL | SOFTWARE

USER'S MANUAL



Principal Author

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BEWOP

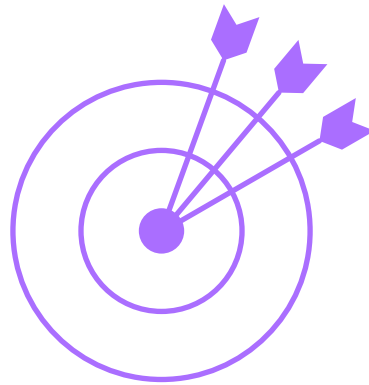
Water Operators' Partnerships are peer support arrangements between two or more water and sanitation operators, carried out on a not-for-profit basis with the objective of strengthening operator capacity.

The Boosting Effectiveness of Water Operators' Partnerships (BEWOP) initiative is producing a series of guidance materials, tools and games to help WOP partners expertly plan and implement WOP partnerships and effectively learn and share knowledge with one another.

Two types of products feature in the second phase of this BEWOP initiative. Process Tools support WOP participants prepare for, design, implement and follow through with their WOPs. Operational Tools support in the transfer of knowledge on specific operational topics relevant for water utilities.

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Objectives

In the traditional planning of maintenance routines, the focus was almost exclusively on the asset condition and assets are replaced only when they are (known to be) about to fail. However, modern asset management understands that the asset's condition should only be part of the total assessment, another essential element being the consequence of failures. From this conception, risk-based renewal planning is now at the heart of infrastructure asset management. Under the BEWOP initiative, IHE Delft has developed an easy to use desktop software tool, RRPAM, which, once input data is provided with EPANET, does the otherwise difficult and time-consuming calculations for risk-based analysis of water networks.



How this tool works

The RRPAM software is an easy to use tool that makes the calculations for users. Only a few simple steps need to be followed to arrive at a cost/risk analysis for asset renewal planning.

1

Download the programme and create a new project.

2

Ensure that you can meet the requirements and have access to:

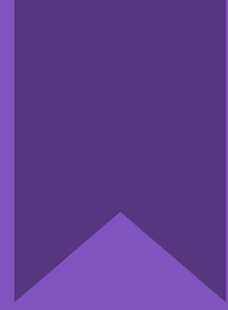
- A water distribution network
- Several parameters (e.g., aging/deterioration constants, interest rate, etc.)

3

Explore whole life - cost curve (damage vs. renewal cost) and risk matrix.

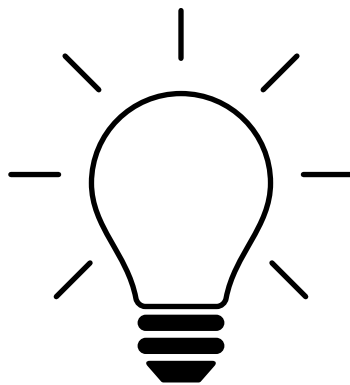
Access the RRPAM-WDS software [here](#).

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Introduction

Risk-based asset management covers a wide arrange of strategies aimed at prioritizing attention to critical steps, machinery, or infrastructure to avoid serious failures that may impact the operation of water distribution systems. Effective asset evaluation and planning include thorough knowledge of asset location, value, condition, and approximate residual life. This knowledge is the basis of future prioritised projections, performance and valuation reports, evaluation and renewal plans.

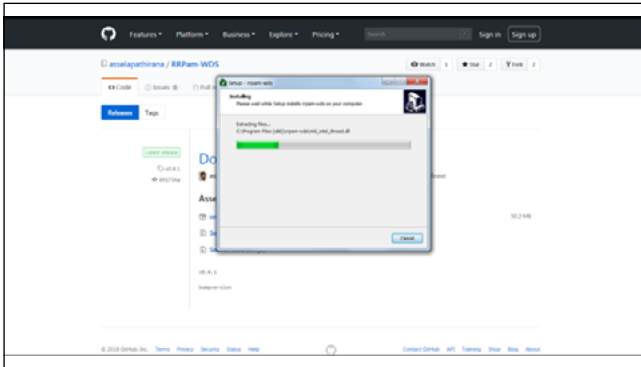
RRPAM-WDS, or Risk-based renewal planning for asset management of water distribution systems, is an educational software tool that demonstrates one of the many approaches for renewal planning in the domain of infrastructure asset management. It uses water distribution networks as a basis for demonstrating the renewal planning approach. However, the principles shown here are applicable for any other infrastructure asset system (e.g., roads, electrical grids, drainage/ sewerage networks).

The purpose of this document is to present the necessary steps needed to perform the tutorial of the RRPAM-WDS tool.

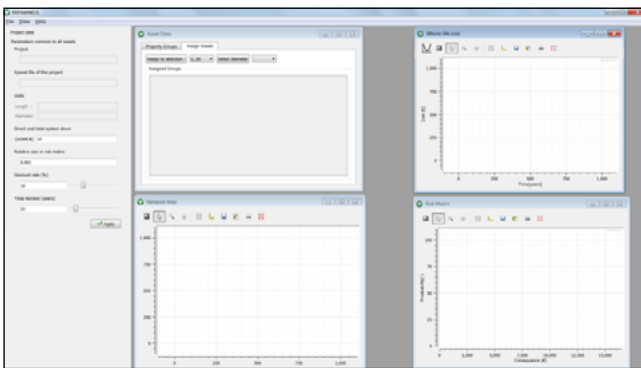
1 Installation and the way forward

Windows installation

Access the latest self-extracting installation files from the release documentation website. Once there you can click on the setup.exe file, accept the terms and conditions. The download will start automatically.



Click on the option of opening the program after being installed. Once the installation is complete, the program will start running. The first view of the program should look like this:



Python installation

If you follow this path, make sure you have installed python and other required packages first. Then, at the command line write:

```
pip install rrpam-wds
```

2 Usage

If you have installed windows self-installation file (as shown in the first part of this manual), simply double-click on the start-menu entry RRPAMWDS.

If you have installed as a python package (e.g. using pip install RRPAM-WDS), then type:

```
python -m rrpam_wds
```

This should open the RRPAM-WDS desktop application. Now we can follow the hands-on tutorial on asset management.

3 RRPAM-WDS tutorial

Requirements

The following information is required to do an analysis with RRPAM-WDS:

- Water distribution network in EPANET 2.0 network format (**.inp**): EPANET 2.0 model uses two model file formats, namely *.net format - which is a binary format- and the text-based 'network file', **.inp** format. RRPAM-WDS can read the (**.inp**) format. If you follow the installation for windows, then the **.inp** example files will be saved in *C:\Program Files (x86)\rrpam-wds\rrpam_wds\examples*
- Reasonable estimations for the parameters of the exponential aging formula by Shamir and Howard (1979)

$$N(t) = N_0 * e^{A*t}$$

Where $N(t) \rightarrow$ number of failures per year, per unit length (# km /year), $t \rightarrow$ age of the asset (in this case pipe), and N_0 and A are aging parameters.

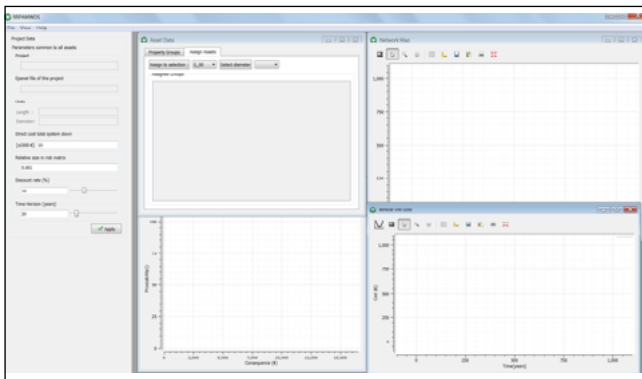
This exponential background-aging model calculates the number of failures per year, per unit length.

For the development of this guideline example data for N_0 and A will be given. However, in real life scenarios, it is important to obtain this data from real measurements or extrapolation exercises.

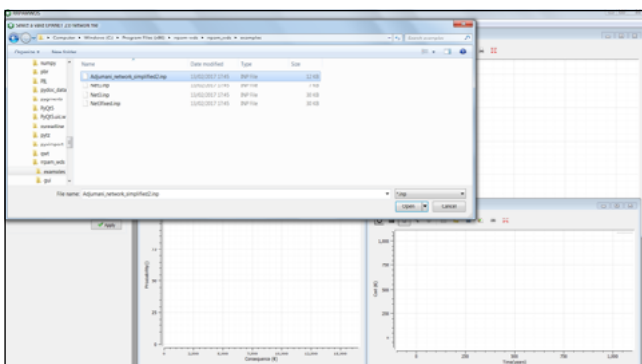
Getting started

1. To begin, create a new project by locating the files you will need. Go to *C:\Program Files (x86)\rrpam-wds\rrpam_wds\examples* and there choose the **Adjumani_network_simplified2.inp**.

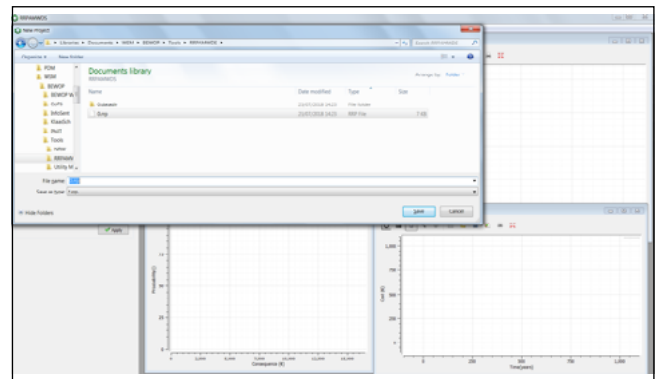
At the beginning, all analysis panes appear blank:



Then, navigate to open *C:\Program Files (x86)\rrpam-wds\rrpam_wds\examples*, find the indicated location of the Adjumani network file. Choose the **Adjumani_network_simplified2.inp** file.

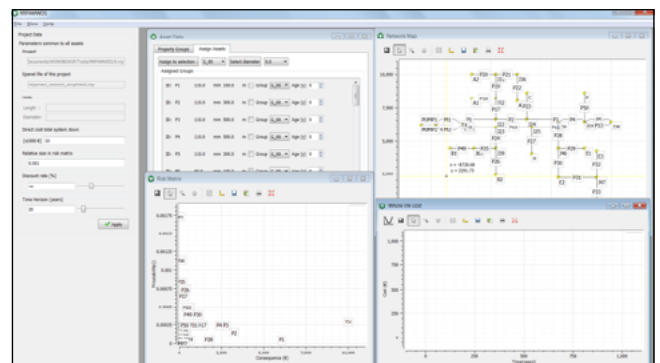


Then, you will be asked to create a new project file. Create a new folder for your exercises, in this case you will create a 0.rrp file, as follows:



After this, the program will take a moment to do the initial hydraulic calculations.

You will see 4 different windows. One will have the Asset Data showing links and characteristics of the network; the second one will have a *Network Map* diagram representing the hydraulic network; the third one will show the *Risk Matrix* plot and the fourth will correspond to the *Whole life cost* (these two will be empty as calculation values have not been entered yet. It should look like this:



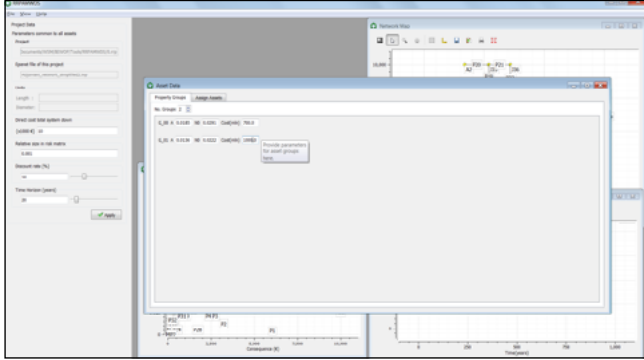
From this 'getting started' phase, you can then take the next steps to perform the first calculations.

Input of failure data

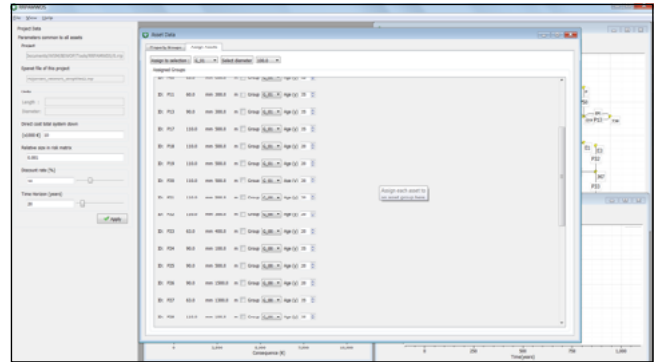
2. In order to perform the first calculations, input the following example data for N_0 , A , and cost of replacement:

Table 1- RRPAM-WDS input data			
Diameter Range	N_0	A	Cost (mil/km)
$d \leq 80$ mm	0.0291	0.0185	0.7
80 mm $>$ d	0.0222	0.0136	1.0

Go to the Asset Data window, there choose the Property Groups tab. For this exercise you will perform the analysis for two groups and enter the data from Table 1. It should look like this:



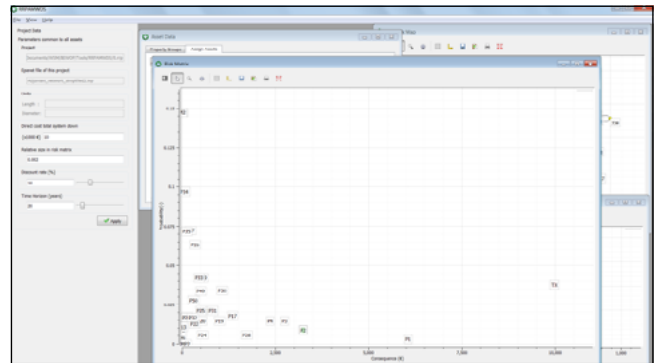
$d \leq 80$ mm, while G_001 has diameter values $d > 80$ mm. The window should look like this:



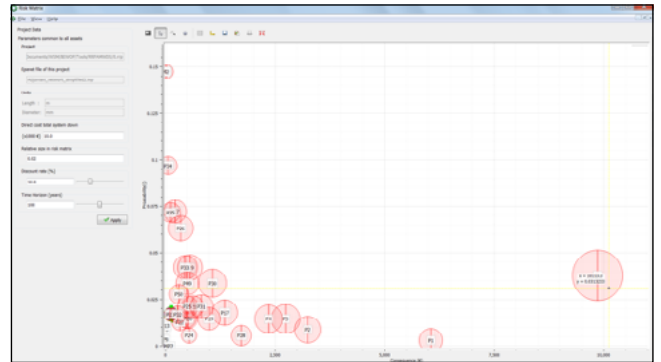
Now the next step is to assign each pipe to one of these two groups. Go to the **Assign Assets** tab on the **Asset Data** (same) window. Use the table below to enter the Age values.

After entering this data, you will have a plot that shows the probability of failure versus the economic consequence for each asset in the network, the window will look like this:

Table 2- Example age values	
Pipe ID	Age (Years)
TX	35
P1	20
P2	20
P9	30
P10	32
P3	20
P11	35
P4	20
P5	20
P13	35
P17	35
P24	35
P27	35
P28	35
P50	35
OTHERS	20



Take a moment to explore this first output. For example, if you adjust the relative size in matrix to 0.02 and set the time horizon to 100 years, you will see a matrix resembling the image below:



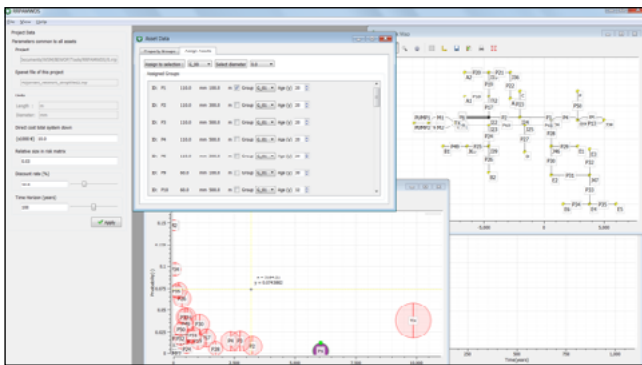
You will need to choose the diameter values for each group, which can to be selected at the top of the window. Remember that G_00 has diameter values

There are number of other facilities provided with these graphs like rectangular-zoom/reset, change axes scales/styles, save graphs in variety of formats, etc. Go explore!

Whole life cost

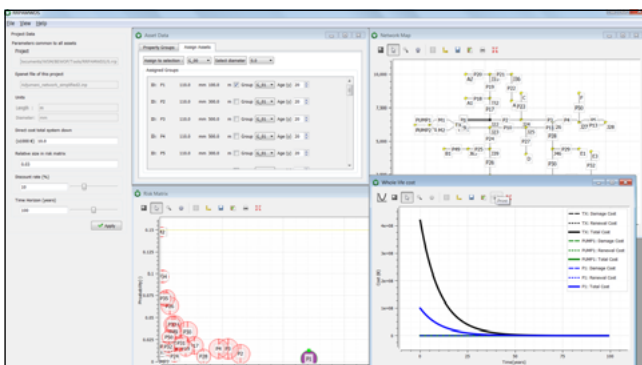
To continue our journey in the RRPAM-WDS tool, we will explore the Whole life cost matrix.

To start, select an asset from the water distribution system. You can do this by selecting one of the assets in the Asset Data window. After clicking on one of them the same asset should appear highlighted in the other window panes (i.e. in the Network Map and in the Risk Matrix windows). It should look like this:



Then, adjust the preferences of analysis regarding the discount rate and the time horizon. For this example, let's choose assets P1, PUMP1, and TX. Also, let's define a discount rate of 10 % and a time horizon of 100 years.

Click on plot button to calculate the Whole life cost and obtain a plot that should look something like this:



In this tutorial we have seen the many ways this tool can help you explore different aspects of risk-based renewal planning for asset management of water distribution systems. The tool is fully available in this [webpage](#).

4 Authors

RRPAMWDS is a software tool that demonstrates the concepts of Risk Based Decision Making and Whole Life Cost Analysis concepts using water distribution networks as examples.

The intended use of the tool is for Asset Management Class.

The software was developed by Assela Pathirana.

Development was supported with a grant under the Global Partnership for Water and Development facility of UNESCO-IHE and Ministry of Foreign Affairs of the Kingdom of Netherlands.

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