Rapid Flood Damage Assessment (RFDA)

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RFDA - User Manual

The best practice for flood mitigation project benefit-cost analysis uses the probabilistic approach based on projected future events. Flood damages in a community is estimated by calculating damages from a series of return floods. The flood depths are computed from hydrologic and hydraulic models. When these are applied to depth-damage curves, the flood damages can be estimated for the flood event. The average annual expected damage (AAD/EAD) can be estimated as the area under the damage-frequency curve.

IBI Group and Ecos Engineering (IBI/ECOS) developed a computerized flood damage assessment system for Alberta Environment in the early 1980s. This system included a computerized database inventory of residential and commercial units within the flood risk areas. It was developed using a CPM micro computer and BASIC program. The system and process developed was ahead of its time. It was the first computerized flood damage assessment system that computed flood damages to each building structure in the floodplain. This system was subsequently ported to the IBM-PC and MS-DOS using the PC File application.

In 1982 the flood damage database management system, or FDDBMS, was used in Alberta and subsequently was also used for flood damage assessment in the Province of Saskatchewan, under a flood damage reduction program undertaken by Saskatchewan Environment. It was then modified for use in the province of Manitoba under a project entitled "Development of Depth-Damage Curves for Residential and Farm Structures in Southern Manitoba", under the Canada-Manitoba Flood Damage Reduction Program for Canada's Inland Waters Directorate.

As a result of the 2013 flood in southern Alberta, Environment and Sustainable Resources Development (ESRD) provided support to update FDDBMS, from a legacy DOS based system, to a graphically based open source system that can integrate spatial GIS data with the database attributes. The new system is called the Rapid Flood Damage Assessment (RFDA) model. The following user manual will describe the key aspects on how to use this application.

1 GENERAL INFORMATION

1.1 System Overview

RFDA is designed to be as easy as possible to use for flood damage assessment. It takes an open data approach giving users ready access to the input and output data. Instead of making users install, learn, and operate a complex relational database system, RFDA input files are stored in standard xls spreadsheet format. RFDA output are in ascii csv format which can readily be imported into Excel or LibreOffice Calc for additional processing and formatting.

To simplify installation and maintenance, RFDA is developed as a Quantum GIS (QGIS) plugin. QGIS is a FOSS4G (Free and Open Source Software for Geospatial) application that can run on multiple operating systems. This means that RFDA can be installed on Windows, MacOS X or Linux computers by users.

RFDA is developed using Python. Python is a programming language that lets you work quickly and integrate systems more effectively. Python supports functional or procedural and object based approaches to software development. It is also supported by many open source applications such as QGIS. RFDA is currently under development (alpha release).

RFDA is a QGIS plugin module that requires QGIS version 2.x to be installed. QGIS is a GIS application that allows you to create, edit, visualize, analyse and publish geospatial information on Windows, MacOS X, Linux, and soon Android.

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1.3 Organization of the Manual

Up-to-date Documentation

The latest version of this document can always be found in the documentation area of the |qg| website at http://www.qgis.org/-en/docs/.

1.4 Acronyms and Abbreviations

Acronym	Description
AAD	Average annual damage
CRS	Coordinate reference system
EAD	Expected annual damage see: AAD
ECOS	Ecos Engineering Services Ltd.
ESRD	Alberta Environment & Sustainable Resource Development
FDDBMS	Flood Damage Database Management System
FOSS	Free and open source software
FOSS4G	Free and open source software for geospatial
GIS	Geographic information system
GNU	Is an operating system that is free software such as Linux
GPL	General public license is a copyright license where derived works
Grade	In RFDAS grade is the elevation at the entrance of the unit
HEC	USACE Hydrologic Engineering Center
IBI	IBI Group Architects Engineers
Linux	FOSS version of Unix operating system for PC workstations
MacOS X	Apple Macintosh Unix based operating system
PID	Parcel identification number
plugin	a software module add on to QGIS
QGIS	Quantum geographic information system
RFDA	Rapid Flood Damage Assessment
Unix	Operating system originally developed by AT&T at Bell System
USACE	US Army Corps of Engineers
Windows	Microsoft Windows operating system
xls	Microsoft Excel spreadsheet file

2 SYSTEM INSTALLATION

RFDA is developed as a Quantum GIS plugin, consequently the user is required to install QGIS on the system. QGIS is a FOSS4G application that will run on Windows, Linux and MacOS X. QGIS can be downloaded from: http://qgis.org/en/site/. Documentation and installation instructions are available from the site.

The RFDA plugin is available from GWN Technologies International by forwarding a request to: support@gwnsys.ca

2.1 Installing QGIS

The latest version of QGIS can be downloaded from: https://www.qgis.org/en/site/forusers/download.html.

QGIS is available on Windows, MacOS X, Linux and Android. Binary packages (installers) for current stable version can be downloaded and installed from the website listed. Install QGIS version 2.x as per instructions from the website.

2.2 Installing RFDA Plugin

The RFDA plugin is supplied as a zip file. Unzip and copy the RFDA folder to the plugin folder for QGIS. The user should refer to the QGIS website to determine the folder location which is dependant on the user's operating system.

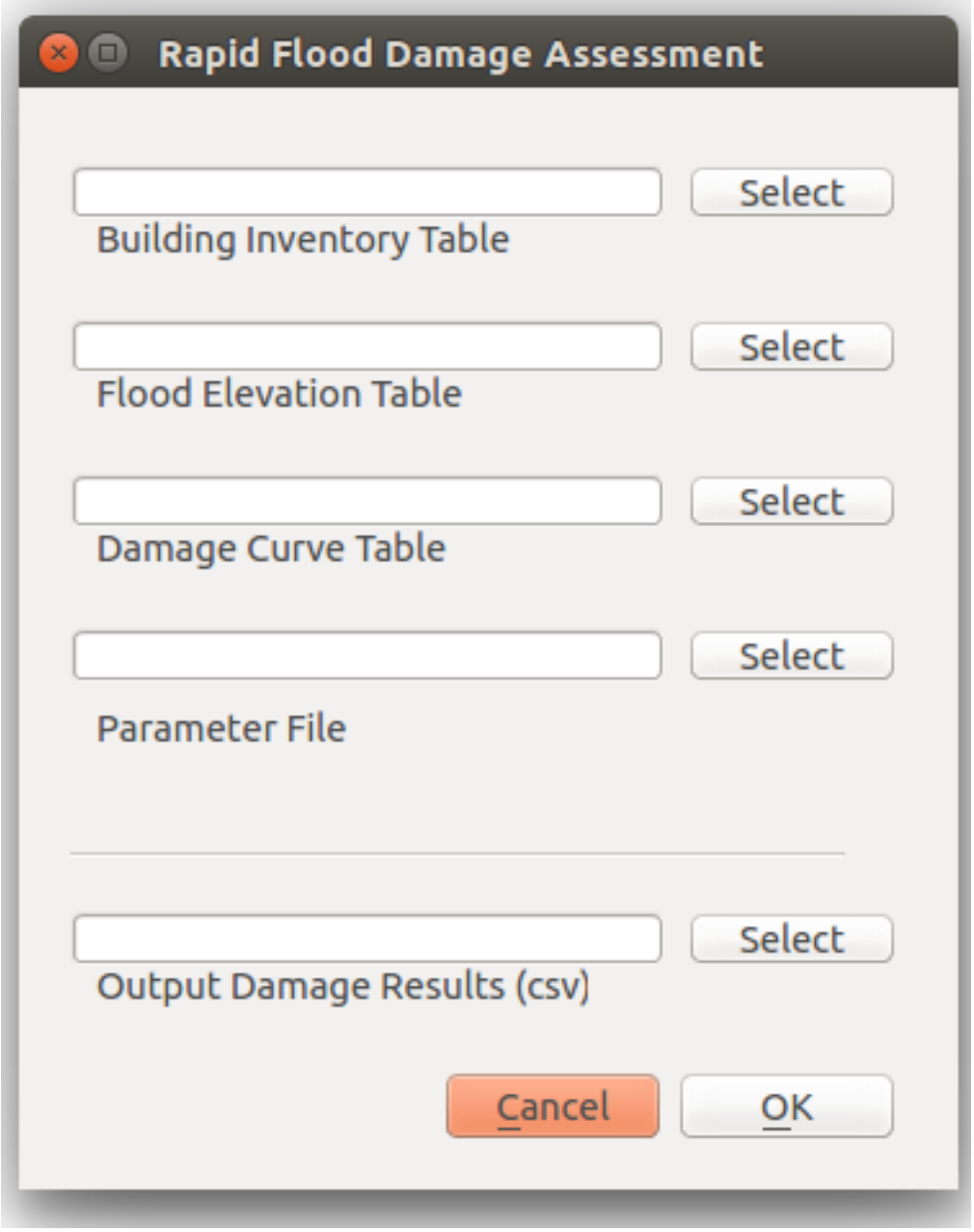
For Windows users it is probably under C:\Users\Username\.qgis2\python\plugins.

For Linux (Ubuntu) it is under \Home\.qgis2\python\plugins.

Copy the RFDA folder into your QGIS plugin folder.

2.3 Running RFDA Plugin

The RFDA plugin requires three files in Microsoft Excel spreadsheet format (xls) input data files and one ascii text based parameter file. The first is a residential or commercial inventory, the second is the flood table with reach, return flood and flood elevations, and the third is the flood damage curves.



2.3.1 Residential-Commercial Inventory

The residential or commercial inventory table is a database of the buildings in the flood prone area. It is recommended that the inventory include all the structures that would be flooded by the highest flood elevation in the reach plus a buffer to take into account basement flooding.

Residential Inventory

Commercial Inventory

2.3.2 Flood Table Inventory

The flood table is a list of all the reaches and the flood elevations for the different return floods on the reach.

Flood Table

2.3.3 Damage Curve Table

The damage curve table lists the depth-damage estimates for contents and structure for various residential classes and types. Commercial damage curves lists contents for different commercial, retail and institutional categories and structural damages by construction type. Damage curves are listed as damage estimated per square metre.

Damage Curves

2.3.4 Damage Estimate Output Data

The calculated flood damages are listed for each return flood with PID, roll or assessment number as the key field and damages for main floor contents and structure and basement contents and structure. For commercial and multi-walkup and apartment buildings the basement contents and structures are replaced with underground parkage damage estimate if it is included.

2.3.5 RFDA Parameter File

The RFDA parameter files is a text file that lists the header field for the return floods, the column of the area field (assessed or building footprint from GIS), floor height, parkade damage per square metre, logical setting for sewer backup and logical for residential or commercial.

3 SYSTEM SUMMARY

RFDA was designed as a QGIS plugin for two reasons. The first was because QGIS provides a solid platform framework for RFDA which could be installed on multiple operating platforms like Microsoft Windows, Linux and Mac OS X, and secondly QGIS provides the user with a professional set of GIS tools that is needed for processing the input data and for analysis of the results after.

QGIS is an Open Source Geographic Information System. The project was born in May of 2002 and was established as a project on SourceForge in June of the same year. The QGIS team has worked hard to make GIS software (which is traditionally expensive proprietary software) a viable prospect for anyone with basic access to a personal computer. QGIS is developed using the Qt toolkit (http://qt.digia.com) and C++. This means that QGIS feels snappy and has a pleasing, easy-to-use graphical userinterface (GUI).

QGIS aims to be a user-friendly GIS, providing common functions and features. The initial goal of the project was to provide a GIS data viewer. QGIS has reached the point in its evolution where it is being used by many for their daily GIS data-viewing needs. QGIS supports a number of raster and vector data formats, with new format support easily added using the plugin architecture.

QGIS is released under the GNU General Public License (GPL). Developing QGIS under this license means that you can inspect and modify the source code, and guarantees that you, our happy user, will always have access to a GIS program that is free of cost and can be freely modified. You should have received a full copy of the license with your copy of QGIS, and you also can find it in Appendix GNU General Public License.

3.1 System Configuration

The RFDA plugin model is designed to help users undertake rapid flood damage assessment on a PC workstation running entirely on open source technologies. For example a user can install Ubuntu (Linux) operating system with LibreOffice Calc, Quantum GIS, and the RFDA plugin which are all FOSS and FOSS4G applications. Alternatively proprietary operating systems like Windows 8.1 and Macintosh OS X are also supported. However this user manual only describes how it works with Linux and Windows workstations.

3.2 RFDA Input Data

The following sub-sections describes the input data in xls format that is required for use in RFDA.

3.2.1 Residential Inventory

The residential inventory data is assembled into an xls spreadsheet by a data wrangler who munges the data from a number of sources including spatial data from a GIS coverage, assessment and other municipal records and databases. The key or core data includes a parcel identification (PID) or assessment roll number as a key field. Other data include building centroid and footprint area. The building centroid is the spatial key in the local municipality's GIS coordinate reference system (CRS), so that its location in the floodplain is consistently depicted in relation to the HEC hydraulic model. Building class and type, together with grade and height to main floor are also required as input. Based on its coordinates the reach information can be added to the inventory. The first 26 columns are used of which 11 are required. Additionally there are three scale factor constants which allows the user to increase or decrease total damage estimated and content and structural damages.

Column	List	Provider	Field Name	Program	Description
A	0	Database	Source-ID-N-10-0		
B	1	Assessment	ADDRESS-C-254		
C	2	Assessment	PID-N-10-0	Integer	Parcel identification or roll number
D	3	Assessment	SuiteNum-N-10-0		
E	4	Assessment	SuiteAlpha-C-254		
F	5	Assessment	HouseNum-N-10-0		Civic number of building
G	6	Assessment	HouseAlpha-C-254		
H	7	Assessment	StreetName-C-254		Street name of building
I	8	Assessment	StreetType-C-254		
J	9	Assessment	StreetQuad-C-254		
K	10	Calculation	Class-C-254	Single character	Classification
L	11	Calculation	Type-C-254	Single character	Structure type
M	12	Assessment Calc	Area_Asses-N-24-15	Real	Area from assessment records
N	13	QGIS	Area_GIS_m-N-24-15	Real	Area from building outline
O	14	Factor	ConstantFa-C-254	Real	Scale factor applied to total damages
P	15	Factor	FactorCont-C-254	Real	Scale factor applied to content damages
Q	16	Factor	FactorStru-C-254	Real	Scale factor applied to structural damages
R	17	Assessment	Suites-C-254		
S	18	Assessment & Review	Basement-C-254	Y/N	Logical to indicate basement or parkade
T	19	Assessment & Review	Height_m-N-24-15	Real	Height from grade to main floor
U	20	QGIS	BLDG-X-N-24-15	Real	X coordinate of building centroid
V	21	QGIS	BLDG-Y-N-24-15	Real	Y coordinate of building centroid
W	22	QGIS	CSEC1-N-10-0	Integer	Starting HEC section of reach
X	23	QGIS	CSEC2-N-10-0	Integer	Ending HEC section of reach
Y	24	QGIS	FID-N-10-0		
Z	25	QGIS	terrain-N-20-5	Real	Grade elevation of building

Click on the link below to see the xls example of residential inventory data.

Residential inventory file example

```
Note: Residential inventory example has been modified for demonstration purposes only.
```

3.2.2 Commercial Inventory

The commercial inventory has the same fields as the residential inventory however the logical in the Basement field is set to Yes if there is underground parking and No if there is none.

3.2.3 Damage Curves

Similarly flood damage curves for residential and commercial are combined into one table. Class and Type values are unique for each category. Note first row is the setup header, second to last are the content and structure damage curves.

Column	List	Row Number	Numeric Type	Program	Description	Example
A	0	1	Integer	RFDA	Number of Damage Curves	38

A	0	2 to N rows	String	RFDA	Class-Type-Number	AA1
B	1	2 to N rows	Integer	RFDA	Number of Curve Points	11
C	2	2 to N rows	Real	RFDA	Frist Elevation	0.00
D	3	2 to N rows	Real	RFDA	First Damage	0.00
E	4	2 to N rows	Real	RFDA	Second Elevation	0.10
F	5	2 to N rows	Real	RFDA	Second Damage	343.50
G	6	2 to N rows	Real	RFDA	Third Elevaion Point	0.30
H	7	2 to N rows	Real	RFDA	Third Damage	421.30
I	8	2 to N rows	Real	RFDA	Fourth Elevation Point	0.60
J	9	2 to N rows	Real	RFDA	Fourth Damage	507.60
K	10	2 to N rows	Real	RFDA	Repeat pairs to N point	
L	11	2 to N rows	Real	RFDA	Repeat pairs to N point	

Damage curve file example

3.2.4 Flood Table

The flood table is extracted from the USACE HEC-RAS model output. The HEC cross-sections are plotted as a layer coverage spatially in GIS. Reaches comprising of two or more sections are selected and the average flood elevation, based on the start and end sections for the reach, is entered into the flood table. The reach information is also added to the flood table.

Column	List	Row Number	Numeric Type	Program	Description	Example
A	0	1	Integer	RFDA	Number of Reaches	55
B	1	1	Integer	RFDA	Number of Frequencies	7
C	2	1	Integer	RFDA	Return Frequency in Years	2
D	3	1	Integer	RFDA	Return Frequency in Years	5
E	4	1	Integer	RFDA	Return Frequency in Years	10
F	5	1	Integer	RFDA	Return Frequency in Years	25
G	6	1	Integer	RFDA	Return Frequency in Years	50
H	7	1	Integer	RFDA	Return Frequency in Years	100
I	8	1	Integer	RFDA	Return Frequency in Years	200

A	0	2 to N rows	Integer	RFDA	Downstream CSEC	9
B	1	2 to N rows	Integer	RFDA	Upstream CSEC	10
C	2	2 to N rows	Real	RFDA	Return Flood Elevation (m)	1027.280
D	3	2 to N rows	Real	RFDA	Return Flood Elevation (m)	1028.355
E	4	2 to N rows	Real	RFDA	Return Flood Elevation (m)	1029.000
F	5	2 to N rows	Real	RFDA	Return Flood Elevation (m)	1029.565
G	6	2 to N rows	Real	RFDA	Return Flood Elevation (m)	1030.045
H	7	2 to N rows	Real	RFDA	Return Flood Elevation (m)	1030.255
I	8	2 to N rows	Real	RFDA	Return Flood Elevation (m)	1030.340

Flood table file example

3.2.5 Parameter File

The parameter file is an ascii comma-separated values (csv) file that users input the headers for the return floods, the inventory spreadsheet column for the area value to be used, height between floor levels in metres, value for parkade flooding per square metre, logical for sewer backup and logical for commercial inventory.

```
Sample parameter file. Note no space after the commas:

2 Year Flood,10 Year Flood,20 Year Flood,50 Year Flood,100 Year Flood,500 Year Flood ↩
    ,13,2.7,215,NoSewer,NoCommercial
```

4 Bibliography

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A FDDBMS

A.1 Flood Damage Database Management System

FDDBMS Application

FDDBMS User Manual

B Inventory Process

B.1 Inventory Process

Tutorial on the munging of residential and commercial inventory data to come.

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