EMERGENCY RESPONSE PLANNING FOR HEAVY RAIN RISKS

Review of the existing hazard analysis – Manual

Thomas Huber[1], Albert Schwingshandl[1], Ines Fordinal[1], Raimund Heidrich[1]

[1)] RIOCOM – Office for Water Management and Environmental Engineering

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Authors Thomas Huber[1] ,Albert Schwingshandl[1], Ines Fordinal[1], Raimund Heidrich[1]

[1)] RIOCOM – Office for Water Management and Environmental Engineering

Contracting authority

Das Land Steiermark
Wasserwirtschaft

Amt der Steiermärkischen Landesregierung
Abteilung 14 – Wasserwirtschaft, Ressourcen und Nachhaltigkeit
Mag.ª Cornelia Jöbstl, DI Rudolf Hornich
abteilung14@stmk.gv.at

Created by

RIOCOM
FLOWING COMPETENCE

INGENIEURBÜRO FÜR KULTURTECHNIK & WASSERWIRTSCHAFT
DI Albert Schwingshandl, Handelskai 92, A-1200 Wien
Tel.: +43 (01) 494 16 87-0 E-Mail: office@riocom.at
Fax.: +43 (01) 494 16 87-30 Web: www.riocom.at

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Preface

RAINMAN

The Interreg CE project RAINMAN aims to reduce damages caused by heavy rain in urban and rural regions. The project establishes tools for dealing with heavy rain risks for local, regional and national public authorities. The partners jointly develop a transferable toolbox with various tools. The toolbox is available on www.rainman-toolbox.eu.

Emergency Response Toolkit

One tool is the emergency response toolkit. It supports local and regional authorities with manuals and templates in creating emergency response plans for heavy rain events.

The toolkit is available in two different versions:

SINGLE DOCUMENTS

Here specific topics are available as 8 single downloads.

➔ IMPORTANT: Please note the references between the individual documents.

	General information & application assistance
	Recommendations (.pdf)
Step 1 – Review of the existing hazard analysis	
	Manual (.pdf)
	Templates (.zip)
Step 2 – Review of the existing vulnerability analysis	
	Manual (.pdf)
	Templates (.zip)
Step 3 – Define suitable measures	
	Manual (.pdf)
	Templates (.zip)

COMPLETE VERSION

Here all documents are available as 1 complete download.

➔ IMPORTANT: Please note that the numbering of the chapters differs from the version of the single documents.

	Emergency Response Toolkit (.zip) Content of the ZIP-File Part A – Recommendations & Process flow Part B – Templates

1. Introduction

The hazard analysis is the first basic step in the emergency response planning process and forms the basis for further analysis and planning. This toolkit implies that hazard and risk maps are already available. Hence this process step aims to review existing hazard material (data and maps) focusing on the creation of an emergency response plan. If no hazard map is available, one should be created following the steps in *"RAINMAN Tool Assessment and Mapping"*.

The goals of reviewing the hazard analysis are to know about your region's endangered areas and about scenarios critically endangering your region. In addition the sources of forecast data (i.e. precipitation forecasts) shall be evaluated in order to build the basis for creating a warning and alarm system. Further, relevant stakeholders may be defined in an early process stage to be aware of who needs to be considered and to gain additional knowledge about the hazard situation. Therefore the user will be lead through different questions and tasks, concerning observed past events or any other available hazard data, eventually related to measuring or modelling approaches.

At the end of the hazard analysis, the user will:

- be aware of the data quality of the hazard data,
- know which areas are critically endangered,
- know which heavy rain scenarios are critically endangering the region and
- know where to obtain precipitation forecast data and of which quality this data is.

HAZARD ANALYSIS - Review				Template
Review current situation				
	Review all your existing hazard data and maps. If no hazard map is available, create one following the *"RAINMAN Tool Assessment and Mapping"*.	Task	H1.T1	B1.1
Sources				
	What kind of precipitation/hydrological data was used creating the hazard map? What do you know about past scenarios? Which forecast data is available in your region?	Question	H1.Q1	B1.1
	Where are the critical hazard points/areas in your region regarding run-off generation?	Question	H1.Q2	B1.2
Pathways				
	What kind of hydraulic data was used creating the hazard map?	Question	H1.Q3	B1.1
	Where are the critical hazard points/areas in your region regarding flowpaths? Also consider river floods and/or problems with the sewer system.	Question	H1.Q4	B1.2
Data quality and area characteristics				
	Evaluate the hazard data complexity.	Task	H2.T1	B1.1
	Evaluate your region's landform and reaction time.	Task	H2.T2	B1.1

HAZARD ANALYSIS - Review				Template
Creation of documents				
	Mark the significant critical hazard points/areas in the hazard map.	Task	H3.T1	-
	Additionally mark points in the hazard map where hazard observations might be useful.	Task	H3.T2	-
	Describe the significant critical hazard points/areas in Form B1.2.	Task	H3.T3	B1.2
	If possible, analyse past heavy rainfall events and figure out which events may cause damage.	Task	H3.T4	B1.1
	Working Map: Hazard	Map	H3.D1	-
	Table: Critical Hazard Areas	Document	H3.D2	-
Stakeholder				
	Stakeholder Workshop: Hazard	Stakeholder	H4.S1	B1.1 B2.1 B2.4 B2.5

2. Review current situation (H1)

In order to evaluate the data availability and quality of the hazard data, the current situation shall be reviewed. All available maps and data shall be re-analysed considering that this information will be used for the planning of measures.

As part of reviewing the current situation stakeholder involvements shall be planed from the beginning. In Chapter 5 you can find further details on the identification of relevant stakeholders and hosting a stakeholder workshop. It is important to think about the timing of your stakeholder involvement (not too early so detailed preparation is possible and knowledge about the data and the overall process is available but early enough for genuine participation).

Review all your existing hazard data and maps. If no hazard map is available, create one following the *"RAINMAN Tool Assessment and Mapping"* **Question H1.T1**

This toolkit implies that hazard maps are already available. Hence, the first process step is to review all the existing data and maps. All further tasks are based on the existing data and maps. If no hazard map is available, one should be created following advises in *"RAINMAN Tool Assessment and Mapping"*.

Evaluate which maps are available. Document or list your findings in Form B1.1.

Sources

Sources, in the context of this toolkit, can be described as the cause or origin of a hazard. Regarding flash floods or pluvial flooding, the source is a discrete rainfall event with very high amounts of precipitation per unit of time. The resulting run-off generation is also part of the sources (Sauer et al. 2019). The generation of run-off follows the topography (mountainous to lowland) as well as the hydrological conditions like infiltration (closely related to soil saturation) or interception (closely related to vegetation).

In this process workflow the current situation review regarding the sources, aims to evaluate the quality of precipitation and hydrological data. Additionally, past scenarios shall be reviewed focusing on how to figure

out which rainfall scenarios are most critical. In order to build up a warning and alarm concept in future process steps, it is important to be aware of the availability of forecast data for your region. Also the most critical hazard points or areas regarding run-off generation shall be evaluated.

In this very beginning of the process it might already be useful to include relevant stakeholders (see H4.S1).

What kind of precipitation/hydrological data was used creating the hazard map? What do you know about past scenarios? Which forecast data is available in your region? **Question H1.Q1**

Precipitation data is an important prerequisite not only to link the potential inundation areas with specific rainfall scenarios, but also to develop a warning and alarm system in order to apply certain risk reduction measures (M3.T2). Hence it is necessary to be aware of which data was used to depict the hazard in your hazard map, and be capable of linking these scenarios with past heavy rainfall events and values obtainable from forecast models.

Used data

Evaluate which data was used to create the hazard map. Data can be available in different levels of complexity. The following example table gives a hint on how the data can be classified. For detailed classification see the recommendation in "RAINMAN Tool Assessment and Mapping – Expert Corner". Use Form B1.1 for documentation.

	Level 1	Level 2	Level 3
Precipitation Data	Station data (measured values)	Radar data (measured values)	Design values (statistically evaluated values)
Hydrological Data	observations	observations	Infiltration models

Past scenarios

What do you know about past scenarios? Ask people with local knowledge about what they know about past heavy rainfall events. When did the last events happen? Do you see any increasing frequency of heavy rainfall events? Which amounts of rainfall where recorded in which time? Document all your findings, even if they rely only on observation and not on detailed measurements. Use Form B1.1 for documentation.

Forecast data

Which forecast data is available in your region? Is there any kind of meteorological service available, providing precipitation forecasts? Is a heavy rain warning service available? Eventually you can even obtain a detailed short term precipitation prognosis (now-casting). Heavy rain warnings or precipitation forecasts can be obtained by different organisations like meteorological or hydrographical services, but often these data is not free of charge. Eventually heavy rain warnings in your region are directed to regional governmental authorities, who are then informing the single municipalities. Use Form B1.1 for documentation.

Input:	*Hazard map (-)* *Local knowledge of stakeholders (H4.S1)*
Output:	*Summary and analysis of data used for hazard maps ⇨ H2.T1* *Past flood events ⇨ H3.T4, M2.T3* *Availability and quality of precipitation forecast ⇨ H3.T4, M2.T3*

Where are the critical hazard points/areas in your region regarding run-off generation? — Question H1.Q2

Run-off is generated where precipitation arrives on the soil more quickly than it can be absorbed, or when the soil is saturated or impermeable. The first situation most likely corresponds to what happens during flash flood scenarios, while the grade of soil saturation is critical during long lasting rainfall events. For each of the different possible hazard scenarios, different prerequisites apply. Hence, when thinking about critical hazard points regarding run-off generation, scenario specific parameters need to be considered as well.

Think about points or areas in your region where large amounts of water tend to start flowing on the surface during heavy rain events. Are there any differences during the year (vegetation period vs. winter months)? May ground sealing worsen the situation there? Document the points or areas that you consider important in Form B1.2.

Keep in mind these areas, when any structural changes are planned. Keep in mind that any structural changes not considering the process of run-off generation might worsen the hazard situation.

Input:	*Hazard map (-)* *Local knowledge of stakeholders (H4.S1)*
Output:	*Collection of hazard points/areas ⇨ H3.T1*

Pathways

The pathway describes the route of the rainwater from the point of impact on the surface towards a receptor (Sauer et al. 2019). Following this definition, the pathway is the linkage between precipitation and vulnerable object hence mitigation measures acting to reduce the hazard are most effective in the pathways (e.g. barriers, dams, retention basins).

Regarding the pathways, the workflow aims to classify the quality of the hydraulic data according to the three complexity levels. Furthermore, critical hazard points in the flowpaths shall be evaluated. Here, floods caused by high discharge in rivers need to be considered, as well as known problems with the sewer system.

What kind of hydraulic data was used creating the hazard map? — Question H1.Q3

Hydraulic data is important to know about potentially flooded areas. The data can only depict known scenarios.

Evaluate which data is available. Data can be available in different levels of complexity. The following example table gives a hint on how the data can be classified. For detailed classification see the recommendations in "RAINMAN Tool Assessment and Mapping – Expert Corner". Document your findings in Form B1.1.

	Level 1	*Level 2*	*Level 3*
Hydraulic Data	*Observations during events*	*GIS-based flow accumulation*	*Hydrodynamic modelling*

Input:	*Hazard map (-)*
Output:	*Summary and analysis of data used for hazard maps ⇨ H2.T1*

Where are the critical hazard points/areas in your region regarding flowpaths? Also, consider river floods and/or problems with sewer systems. — Question H1.Q4

As the pathway is crucial for a hazard to occur, it is important to know whether there are any hotspots or specific problems regarding flowpaths. Further, river floods may cause additional problems, as river floods may overlay with surface run-off after heavy rain events. Also, think about critical points in the sewer system.

Are there any culverts which, if blocked, critically redirect run-off? Are there any points in the sewer system where overflow occurs frequently? Are there any additional hazards concerning river floods? Document your findings in Form B1.2.

Input:	*Hazard map (-)* *Local knowledge of stakeholders (H4.S1)*
Output:	*Collection of hazard points/areas ⇨ H3.T1* *Information on related hazards (river floods, sewer system) ⇨ H3.T1*

3. Data Quality and Area Characteristics (H2)

After reviewing the current situation, this process step works like a filter, to filter out the relevant hazard points/areas. The existing and/or collected data have a certain quality/complexity. In order to be able to take further steps in the toolkit, it is essential to be able to classify the quality/complexity of the data situation in your region. In addition, the area characteristic plays an essential role in the planning of measures.

Evaluate the hazard data complexity — Task H2.T1

Reviewing the current situation (Chapter 2), data and information regarding the sources and the pathways of heavy rain-induced flooding were collected (H1.Q1, H1.Q3). In each previous step, the levels of complexity were assigned. Based on these principles, an expert assessment of the comprehensive complexity level has to be carried out.

Assess the complexity level of the hazard data. Use all previous classifications and information, which was assembled in the phase of reviewing the current situation. The classification should be done based on an expert assessment. Refer to the information shown in "RAINMAN Tool Assessment and Mapping - Expert Corner". If you vary between two levels, choose the lower level. Document the assumptions you made and the level you chose in Form B1.1.

	Level 1	*Level 2*	*Level 3*
Hazard Data Complexity			

Input:	*Summary and analysis of data used for hazard maps (data complexity H1.Q1, H1.Q3)*
Output:	*Overall hazard data complexity ⇨ M2.T1*

Evaluate your region's landform and reaction time — **Task H2.T2**

Based on the landform of your region a basic assumption of key processes can be made. This attribution gives a hint on the reaction time during a flood event. The reaction time is an important input parameter to plan adequate emergency measures.

Evaluate your region's landform. With this information and the following table you can estimate a landform specific reaction time. Note that this is only a basic estimation. Eventually refer to the information in "RAINMAN Tool Assessment and Mapping – Expert Corner". Document your assumptions and estimations in Form B1.1.

Landform		*Run-off and discharge dynamics*		*Reaction time*
mountainous	→	*very high*	→	*very short*
hilly	→	*high*	→	*short*
lowland	→	*low*	→	*long*

Input: *Landform (H2.T2)*

Output: *Estimated reaction time ⇨ M2.T3*

4. Creation of documents (H3)

After reviewing the existing hazard maps and necessary input data for setting up an emergency response plan, this process steps aim to prepare all the data and maps in a way to be implemented in the final plan. The quality of the existing data (H2.T1) needs to be considered throughout the whole process. All detailed process steps are carried out already giving thought to the following planning of measures.

Mark the significant critical hazard points/areas in the hazard map. — **Task H3.T1**

Hazards in the context of heavy rain induced flooding are typically described by parameters of the flood water in terms of (spatially differentiated/explicit) water level, inundation duration, flow velocity and direction as well as sediment load, flowing debris and released contaminants (Sauer et al. 2019).

Within these areas, specific points might be present where critical hazards exist. This could be culverts or bridges, where – if blocked – run-off could be redirected, or areas where a significant amount of run-off is generated. Also the sewer system needs to be considered here. Inlets can get blocked during heavy rain events, eventually certain points tend to overflow frequently.

Take the hazard map and mark all those points or areas where the hazard situation might get critical. Consider the quality/complexity of the data the hazard map was created with (with data complexity level 1, you might not be able to give a reliable assumption of certain critical hazard points). Also, consider the collection of hazard points you created in H1.Q1 and H1.Q4.

Input: *Hazard map (-)*
Collection of hazard points/areas (H1.Q2, H1.Q4)
Information on related hazards (river floods, sewer system) (H1.Q4)
Overall hazard data complexity (H2.T1)

Output: *Working map: hazard ⇨ H3.T4, V3.T1*

Additionally mark points in the hazard map where hazard observations might be useful. **Task H3.T2**

Observations during the hazard process are important not only to set adequate measures at the right time during the observed events, but also to gain knowledge for future events and the adaption of your emergency response plans. Observations can be carried out on points near the sources or flowpaths where the hazard is most likely visible.

Take the map you edited in step H3.T1 and add points where hazard observations might be useful. These points should mark locations for the observation of critical hazard points. They must not be endangered themselves in order to guarantee safety for the observers.

Input:	*Significant critical hazard points (Working map: hazard H3.D1)*
Output:	*Working map: hazard ⇨ H3.T4, V3.T1*

Describe the significant critical hazard points/areas in Form B1.2. **Task H3.T3**

In order to document all your findings of the previous steps (H3.T1 and H3.T2) a list should additionally be created where all the information is written down.

Take Form B1.2 and describe all your findings. This will help you to get a good overview about your critical hazard points/areas.

Input:	*Working map: hazard (H3.D1)*
Output:	*Table: critical hazard areas ⇨ H3.T4, V3.T1*

If possible, analyse past heavy rainfall events and figure out which events may cause damage. **Task H3.T4**

Heavy rain induced floods tend to be events with very little reaction time from the beginning of the rainfall until flooding happens. In future process steps you are asked to develop a warning and alarm tool which should help you assessing the expected events intensity. These intensity estimations are to facilitate the decision which measures need to be set. This warning and alarm tool will be based on different parameters affecting the intensity of a critical damage event. These parameters are:

- Rainfall intensity (mm/h)
- Ground sealing in the affected area
- Temperature (if snow is prevalent)
- Vegetation
- Current soil moisture content

According to your hazard maps and observed past events, analyse under which conditions a heavy rainfall event may become a critical damage event. Consider the parameter defined above.

Input:	*Working map: hazard (H3.D1)* *Table: critical hazard areas (H3.D2)* *Availability and quality of precipitation forecast (H1.Q1)* *Past flood events (H1.Q1)*
Output:	*Critical damage scenarios, parameter settings ⇨ M3.T2*

Working Map: Hazard	Map H3.D1

The output of Task H3.T1 and H3.T2 is the "Working Map: Hazard". If you know how to use GIS Software, you might digitize your results. Otherwise keeping your results on a paper map is sufficient.

Table: Critical Hazard Areas	Document H3.D2

The output of Task H3.T3 is the "Table: Critical Hazard Areas" with a detailed description of hazard points.

5. Stakeholder (H4)

Stakeholders are people who are relevant to be included in the process because they:

- *need to be included by legal reasons*
- *are vital for planning and applying of measures*
- *have additional knowledge (e.g. of the local situation)*
- *collaborated in similar projects*
- *can provide useful connections*
- *can enhance or block the process*
- *represent the public*
- *represent a particularly vulnerable part of the public (e.g. people with special needs, children)*

Often, relevant stakeholders are representatives of the public administration, politics or NGOs. Sometimes it might even be useful to include directly affected citizens.

The following table gives an overview about potential stakeholders for the hazard analysis.

Stakeholders	Function	Competences/Input	Level
Users of the emergency response plan			
Regional government	Head of operations	Regional knowledge, experiences	Regional
Local government, mayor	Head of operations	Local knowledge, experiences	Local
Local/Regional Crisis unit	Support of operational head	Local knowledge, experiences	Regional/Local
Emergency organisations	Fire brigade, police, rescue service	Local knowledge, experiences	Regional/Local
Technical input			
Water management	Technical Input	Local and regional knowledge, technical knowledge regarding hydrology, hydraulics, precipitation data	Regional
Local experts	Technical Input	Local knowledge, experiences, past/historical events	Local
Connections			

Stakeholders	Function	Competences/Input	Level
Emergency response units	Technical Input, Nationwide coordination	Knowledge of planning and applying of measures	Nationwide/Regional
Public			
Citizens, interested people, affected persons	Potentially affected, volunteers	self-provisioning, participation at exercises	Local

Another considerable group is the common public, which can also be included in the participation process. Nevertheless, the public needs to be at least informed about the results of your planning process (M4.S3).

A checklist on the stakeholder participation as part of the hazard analysis (Form B2.1) shall help you to consider all important process steps. In order to document the identification process of the relevant stakeholders, Form B2.4 can be used.

To make sure that all the relevant stakeholders were invited, it might be useful to evaluate the entry list after the first stakeholder meeting.

Further meetings with key stakeholders are possible as well.

Stakeholder Workshop: Hazard — **Stakeholder H4.S1**

In order to review the current hazard situation and all your available data and maps, local knowledge regarding the hazard processes is indispensable. Stakeholders should be included from the beginning. In order to be well prepared for the first workshop it is essential to deal with the existing hazard data as well as with the basic concept of this toolkit (i.e. what steps are planned to build up an emergency response plan, what is the structure of an emergency response plan), before the stakeholder workshop is held.

The following bullet points give information about how the stakeholder workshop can be organised:

- Inform

  In the first part of the workshop, the participants are informed about:

  - The purpose of the emergency plan
  - The planned steps to build up the emergency plan
  - Expectations on the participants (i.e. what should be worked out together)
  - Relevant hazard process depicted in the existing hazard map
  - Which scenarios are shown in the hazard map

- Discuss & Participate

  After the informational part, the stakeholders are invited to:

  - Bring in their knowledge following the questions concerning the current situation
  - Review the modelled scenarios in the existing hazard maps and identify critical hazard points/areas
  - Make suggestions on potential hazard observation points
  - Name persons who may have additional useful knowledge

Prepare the stakeholder workshop

Review all the existing material and make yourself confident with the planning process. Identify the entire relevant stakeholders using the table above and document the relevant stakeholders in Form B2.4. Use Form B2.1 as a checklist.

Host the stakeholder workshop

Host a meeting/workshop where stakeholders are informed about your planning process. Furthermore all the questions concerning the current situation as well as suggestions for potential hazard observation points shall be discussed. For the procedure of the workshop refer to the above list. All the feedback of the stakeholders shall be documented (Form B2.5).

Follow-up processing

After the workshop was held, sort out all the relevant feedback and document it in Form B1.1. Use Form B2.1 as a checklist. If it turns out that it might be useful to discuss additional topics within a smaller group, further meetings with key stakeholders are possible.

RAINMAN Key Facts

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Lead Partner

LANDESAMT FÜR UMWELT, LANDWIRTSCHAFT UND GEOLOGIE | Freistaat SACHSEN

Saxon State Office for Environment, Agriculture and Geology

rainman.lfulg@smul.sachsen.de

Project Partner

Saxon State Ministry of the Interior | STAATSMINISTERIUM DES INNERN | Freistaat SACHSEN

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INFRASTRUKTUR & UMWELT Professor Böhm und Partner

INFRASTRUKTUR & UMWELT
Professor Böhm und Partner

RAINMAN@iu-info.de