Interreg
CENTRAL EUROPE

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RAINMAN

The RAINMAN-Toolbox

Be prepared for the next heavy rain event!

DEAR READER,

Central Europe is facing an increase in weather extremes as a result of the ongoing climate change, such as heavy rain. It is hardly predictable where and when exactly extreme amounts of precipitation will occur. In principle, any place can be affected. Even away from watercourses, heavy rain can cause high levels of damage, e.g. through flash floods or the erosion of sediment as a result of uncontrolled surface runoff. For this reason, flood risk management measures established in the European Union for endangered areas along rivers or coastlines should be supplemented by measures that have a more extensive effect and fit in with local conditions. Heavy rainfall risk management is therefore primarily a matter for local authorities. Orientation and support by regional and national institutions is crucial for this though.
Approaches in the various Central European regions and states regarding heavy rain risk management vary greatly. The Interreg CENTRAL EUROPE project RAINMAN perceived this as an opportunity. It aimed at collecting existing tools and methods for heavy rain risk management from different central European regions, testing them in practice, supplementing and developing them further as role models. The focus was on aspects of risk prevention, and the dissemination of the accumulated knowledge was a key aspect of the project work.

The brochure **"The RAINMAN-Toolbox - be prepared for the next heavy rain event!"** summarises the most important starting points, working steps and fields of action with a transnational validity. It introduces the contents and structure of the website of the same name, which was developed between 2017 and 2020 in the RAINMAN project under the leadership of the Saxon State Office for Environment, Agriculture and Geology.

With this publication we would like to encourage you to explore the topic more intensively. Every municipality, every owner, every land user - and thus every citizen is addressed to use the suggestions developed and to reduce the risk by adapting their own activities in their area of influence - for the benefit of all of us and for the benefit of future generations who will have to cope with the consequences of current decisions.

Norbert Eichkorn
President of the Saxon State Office for Environment, Agriculture and Geology

IMPRINT

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- Croatian Waters, Croatia
- T. G. Masaryk Water Research Institute, Czech Republic
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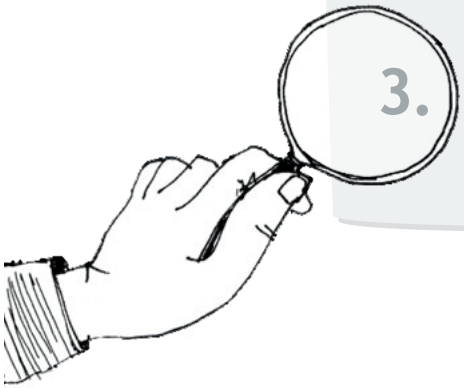
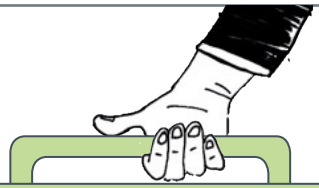


1. ABOUT RAINMAN AND THE TOOLBOX

Heavy rain events can hit any location with only very short warning time. Every year people die, thousands lose their homes, and environmental damages like water pollution occur. With this as a starting point, the RAINMAN project began its work in 2017 with a consortium of ten partner institutions from six countries. The partnership jointly developed innovative methods and new tools to support municipalities and regions to cope with the hazards of heavy rain and to mitigate heavy rain risks as far as possible.

These management tools and methods were put together in the **RAINMAN-Toolbox**, an information platform for municipalities and further local and regional stakeholders with a collection of the tools developed in the RAINMAN project and tested in different pilot regions.



THE TOOLBOX CONTAINS

- A collection of methods for **ASSESSMENT AND MAPPING** of heavy rain risks
- Inspiration and guidance regarding **RISK COMMUNICATION**
- Guidance for the planning and implementation of **RISK REDUCTION MEASURES**
- A catalogue of **OUR STORIES:** good practice examples for the integrated reduction of heavy rain risks

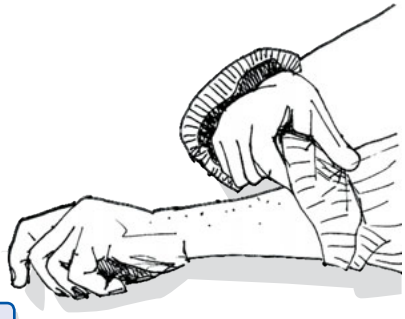
"In exchange with local stakeholders, methods and measures were tested and implemented in our pilot activities. We put our experiences and our extensive theoretical knowledge base from six countries together into the RAINMAN-Toolbox!"

Dr.-Ing. habil. Uwe Müller, Saxon State Office for Environment, Agriculture and Geology, DE

Explore the "RAINMAN-Toolbox" at
http://rainman-toolbox.eu

Heavy rain events with floodings can cause damages anytime and anywhere, even if a location is not close to a water body. Most of the time heavy rain events appear suddenly and there is practically no warning time. They can lead to local flooding, e.g. due to uncontrolled surface runoff in the area. Serious damage can ensue if no precautionary measures are taken.

And what makes it even worse:
Experts expect heavy rain events to occur more frequently in the future.



"ARE YOU READY TO TAKE ACTION?"

It is important to identify areas with a high risk using tailored assessment and mapping methods!
The tool **"ASSESSMENT and MAPPING"** explains the different elements and steps that a risk assessment for heavy rain induced flooding might consist of. It shows different methodological approaches for these steps and describes their pros and cons as well as data demands and possible results.

Those potentially affected have to be aware of and understand the risks of heavy rain sufficiently to act accordingly or implement risk reduction measures. Therefore, risk communication is key!
The tool **"RISK COMMUNICATION"** explains how and which messages should be conveyed to the relevant persons and institutions. Good practice examples show specific possibilities for action and inspire your own action.

At local level, precautions must be taken to minimise the damage! The tool **"RISK REDUCTION MEASURES"** helps local and regional administrations to find, select and implement suitable precautionary measures and gives additional guidance in the fields of spatial planning, early warning, emergency response, prevention and retention.

ASSESSMENT AND MAPPING

For local authorities, successful heavy rain risk management starts with assessment and mapping in order to identify, locate and evaluate potential heavy rain hazards and risks.

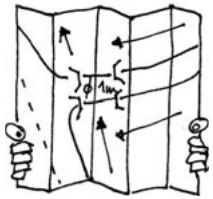
Local authorities need to know where the water from heavy rain events accumulates and where it can pose hazards and risks to people, infrastructure and property on its way to the next river or lake. Mapping heavy rain hazards and risks helps to communicate the topic e.g. to citizens or emergency management units in the municipality.

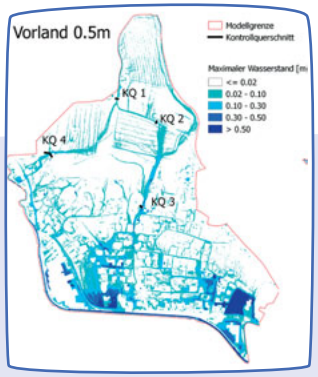
The tool ASSESSMENT and MAPPING gives guidance and answers questions for practitioners and experts.

Link to the tool "ASSESSMENT and MAPPING"
http://rainman-toolbox.eu/home/tools-methods/assessment-mapping/

PRACTITIONERS' CORNER

The systematic approach of public administrations to the issue of heavy rain flooding is relatively new in most European countries. However, a few countries already provide nationally or regionally agreed approaches, which are summarised in guidelines. The RAINMAN-Toolbox introduces you to a collection of tested and approved practices in the RAINMAN partner countries and answers the most important questions to kick-start heavy rain assessment and mapping:





WHICH METHODS FOR HAZARD ASSESSMENT AND MAPPING COULD HELP ME?

For the assessment of heavy rain hazards, a large variety of methods is available and has already been applied in different European countries. There are three basic types of methods: empirical methods, flow path analyses and hydrodynamic simulations. The toolbox provides you with an overview over the different methods and lists the RAINMAN experiences with these as well as with additional assessment and mapping methods.

WHY AND HOW COULD I DO RISK ASSESSMENT AND MAPPING?

It is important to identify possibly affected persons, such as toddlers in a basement level preschool - and assets, such as crucial hospital infrastructure in unprotected basements! This can be done in a qualitative or quantitative way. In the Toolbox you can find information about many tested and approved good practice examples.

WHICH STAKEHOLDERS SHOULD BE INVOLVED?

As a municipality, it is helpful to get several stakeholders on board of the heavy rain subject such as spatial planners, farmers or citizens and entrepreneurs. They can serve as multipliers and support you to mitigate the risks of heavy rain!

WHAT'S TO BE DONE NEXT?

If you have covered all the basics of assessment and mapping, you can now start the decision-making process for selecting measures! The RAINMAN-Toolbox provides a comprehensive overview over possible measures listed in a catalogue of over 100 risk reduction measures.

OUR STORY FROM UPPER AUSTRIA:

Guideline for numerical simulations for surface flow induced by heavy rain events

"In RAINMAN we wanted to provide an up-to date overview on software packages with their relevant technical features and condense the experiences from the simulation studies into recommendations. These can be used to support administrative authorities in developing requirements for surface flow simulations, in order to achieve comparable results in adequate quality."

Dr. Yvonne Spira, Environment Agency, AT

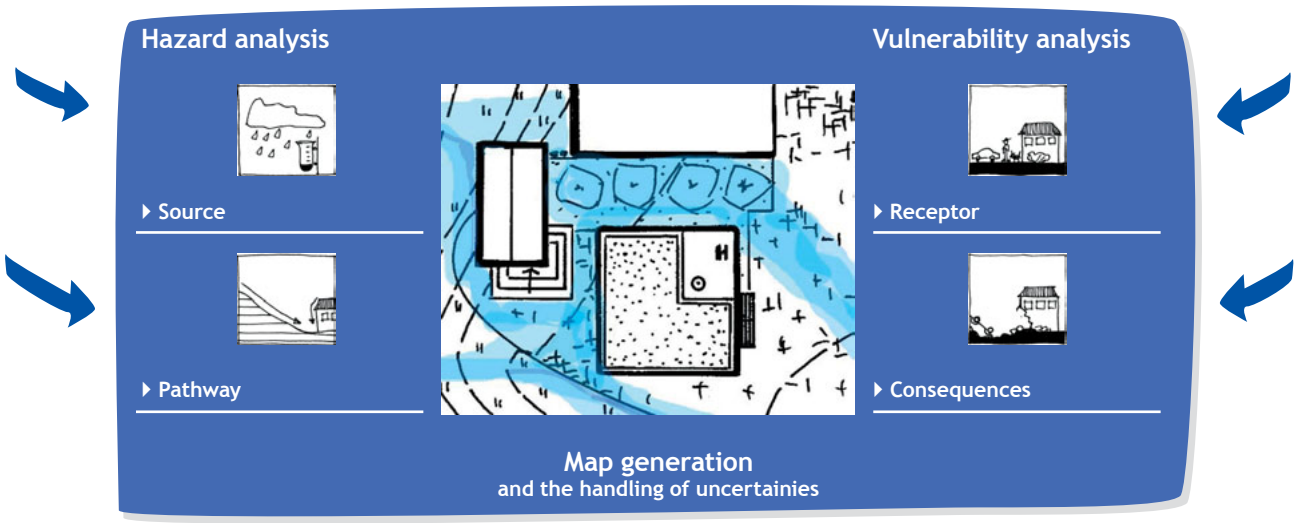
EXPERTS' CORNER

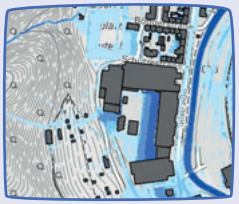
This section is for those who are already familiar with the topic. Here you can find detailed information on available approaches and scientific publications created in the context of the RAINMAN project.

The structure follows a classical risk assessment consisting of

- a hazard analysis that describes the factors that can cause harm and damage such as water levels and flow velocities in the course of a certain rain event and
- a vulnerability analysis that identifies and describes potential receptors that might be harmed or damaged such as people, property or infrastructure elements.

The sub-structure is based on the so-called Source-Pathway-Receptor-Consequence-Concept that describes risks as a path from the origin in form of rainfall and surface runoff generation (source) along flow pathways that meet exposed receptors and cause (negative) consequences.



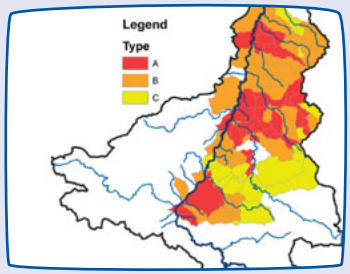


OUR STORY FROM SAXONY, GERMANY: Hydrodynamic simulation with HiPIMS in Meissen

"RAINMAN developed hazard maps for the City of Meissen on the basis of hydrodynamic simulations with the HiPIMS software. Good agreement between simulated and observed flow patterns created confidence on the model and approach. It showed that the quality of the digital elevation model has the greatest influence on the results. Additionally, event documentation is very valuable for the evaluation of the model outputs."

Dr. Axel Sauer, Leibniz Institute of Ecological Urban and Regional Development, DE

MORE INFORMATION ON
ASSESSMENT AND MAPPING



OUR STORY FROM LOWER SILESIA, POLAND: Flash flood hazard and vulnerability maps

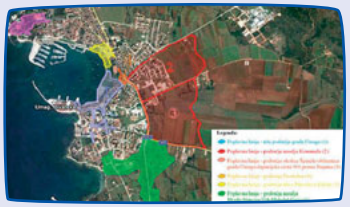
"The applied method for Lower Silesia focuses on physiographic and hydrological parameters as well as retention and land use conditions. It allows the identification and mapping of the elementary catchments that are vulnerable to flash flood generation. As an initial step, the documentation of previous events of flash flood caused by heavy rain is an important basis for the identification and assessment of catchment features prone to flash flood occurrence."

Dr. Eng. Mariusz Adynkiewicz-Piragas, Dr. Irena Otop, Institute of Meteorology and Water Management - National Research Institute (IMGW-PIB), PL

OUR STORY FROM ISTRIA, CROATIA: Heavy rain risk map for river basin Umaški potok

"First of all, prior to the implementation of activities it is necessary to identify the key problems. Special attention needs to be paid to the preparation of input data and parameters as results largely depend on their accuracy: e.g. a quality terrain model. It is also important to select representative rainfall (design storm) and model dynamics. The implemented activities provide assistance for other areas in Croatia that address similar problems."

Alan Cibilić, Croatian Waters, HR



OUR STORY FROM SOUTH BOHEMIA, CZECH REPUBLIC: Critical points analysis

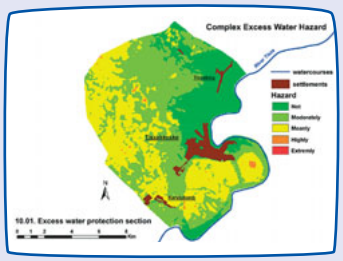
"The methodology of critical points generally aims at the identification of urban (built-up) areas potentially endangered by concentrated surface runoff. A critical point is an indicator of flash/pluvial flood hazard. It expresses an entry spot into an urban area that could potentially be endangered by surface runoff from a contributing area of which the parameters show that a specific area is prone to flash flood generation. The aim of the methodology is to indicate potentially endangered entry spots of heavy rain into settlement areas."

Pavla Štěpánková, T. G. Masaryk Water Research Institute, CZ

OUR STORY FROM TISZAKÉCSKE, HUNGARY:
High-resolution excess water hazard and risk mapping of agricultural areas

"Excess water is a form of temporary water inundation that occurs on flat lands, amongst others due to extreme precipitation. It causes large damages, mainly on farmland. For modelling of the hazard, we have built up a regression kriging model. Concluding we can say that the quality of data has the greatest influence on the results. The main challenge was to to implement the farming methods in the model, as they can decrease or increase the pond effects after heavy rain on flat lands."

Csaba Bozán, Gábor Harsányi, Middle Tisza District Water Directorate (KÖTIVIZIG), HU

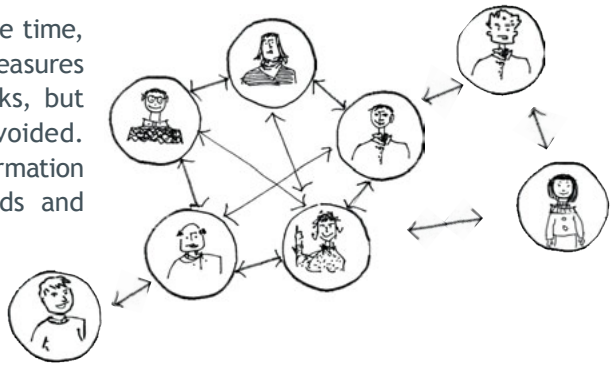


WHY
RISK COMMUNICATION?

Communication of risks and raising awareness are important components of an integrated heavy rain risk management. Risk communication deals with the preparation of information from hazard analysis and risk assessment, but also with the possibilities and limitations of heavy rain risk reduction measures.

WHAT NEEDS TO BE COMMUNICATED?

In order to raise awareness of the risks of heavy rain among those responsible and potentially affected, existing knowledge should be disseminated by appropriate communication activities. This includes communicating where hazards and risks exist at the local level and who could be affected by heavy rain events. At the same time, it needs to be shown which measures can be taken to minimise risks, but also which risks cannot be avoided. A combination of pure information transfer about possible hazards and risks with examples of good practice and success stories motivates those affected and institutions to reduce the risks and sets incentives.



WHOM TO TALK TO?

Different target groups need to be aware of the possible dangers of heavy rain and understand the risks, such as house owners, people working in administration, companies and farmers. Communication activities need to be tailored to these different target groups. Think about whom you want to reach with your messages and choose a target group-specific format and information medium.

OUR STORY FROM POLAND: Get students involved!

"In the RAINMAN project, we set one of our priorities on the development of measures for risk communication on materials for the education sector. We have developed and tested various materials for teachers and students. The feedback from the students and teachers was very positive. We learned that the materials are best received if it can be adapted to different age groups and previous knowledge of the school children."

Dr. Iwona Zdralewicz, Institute of Meteorology and Water Management - National Research Institute (IMGW-PIB), PL

MORE
RISK COMMUNICATION

Recommendations for a successful risk communication

DO'S

- ☑ Regular communication is important to maintain awareness between events.
- ☑ Be innovative! Choose innovative information formats and provide the information in an interesting way.
- ☑ Think about which multipliers you know from the different target groups and whom you can involve in your activities.
- ☑ Target the information at specific addresses and target groups!
- ☑ Pay attention to the clarity of the information provided! Use a clear and target-group-specific language. An easily understandable language is important if the target group is not familiar with the subject.
- ☑ Show that you support the respective target group with the information provided!
- ☑ Show what can be done to reduce the risks and motivate to implement measures! Use good and concrete practical examples to demonstrate the possibilities of heavy rain risk management.
- ☑ Point out uncertainties!
- ☑ Link your public relations work on heavy rain with other relevant topics, such as flood risk management.
- ☑ Combine different communication measures and develop a communication strategy.
- ☑ Monitor and evaluate the measures taken in order to improve them in the future.

DON'TS

- ☒ Don't forget: Heavy rainfall can occur anywhere and with only a short warning time!
- ☒ Don't stir up fears but make it clear that the danger is real.
- ☒ Don't forget your target audience: adapt your language to the recipient!
- ☒ Don't overload your target group with requests, as this will limit their willingness for participation.
- ☒ Don't choose the topic of your communication activity too broadly and do not pack too many topics into one activity.

Link to the tool "RISK COMMUNICATION"
http://rainman-toolbox.eu/home/tools-methods/risk-communication/

COMBINE DIFFERENT STRATEGIES AND TAKE ALL FIELDS OF ACTION INTO ACCOUNT:

Improve early warning!
Learn how to interpret, assess and forward warnings

Organise emergency response!
Adapt your emergency response to heavy rain risk

Prevent damages!
Explore what regional authorities, municipalities and private persons can do to reduce the risks

Retain rainwater!
Learn about different retention concepts

Adapt spatial planning!
Learn about the risk reduction possibilities of different planning instruments

Select suitable measures!
Browse through our catalogue of 100 risk reduction measures

Link to the tool "RISK REDUCTION MEASURES"
http://rainman-toolbox.eu/home/tools-methods/risk-reduction-measures/

PREVENT DAMAGES!

Prevention measures in flood risk management are all those measures which can be taken in times without heavy rain events to avoid or reduce the risk of possible damages or losses.

The main tasks are carried out by municipalities and private persons, they have the highest potential to reduce adverse consequences by protecting life, property and environment.

Possible measures range from local land use planning and legal measures, e.g. for keeping the hazardous areas free of building and infrastructure developments, to natural or technical risk reduction measures.

Public municipal administrations

... are responsible for the sustainable development of the municipality. They are the key to collect available heavy rain risk information, to close information gaps, to steer flood safe housing and infrastructure development, to initiate community measures for flood protection, to initiate emergency management planning for heavy rain flooding and to provide information to the population.

Private persons

... can do a lot to protect themselves and their property from heavy rain flood damages. Houses and other buildings can be designed flood-resilient, existing houses with flood risk can be retrofitted in order to reduce future flood damages. Residents can develop a private alarm plan and ensure financial security, e.g. by taking out a flood insurance policy.

OUR STORY FROM SOUTH BOHEMIA, CZECH REPUBLIC: Design of small retention reservoirs in Horní Olešná

"Rainfalls often have an impact on increasing water volumes in adjacent watercourses. This should be taken into account when revitalising watercourses. In the event of heavy rain, watercourses should be able to take up, retain or slow down the volume of water. For this purpose, small water reservoirs along the stream are proposed."

Dana Fialová, South Bohemian Region, CZ

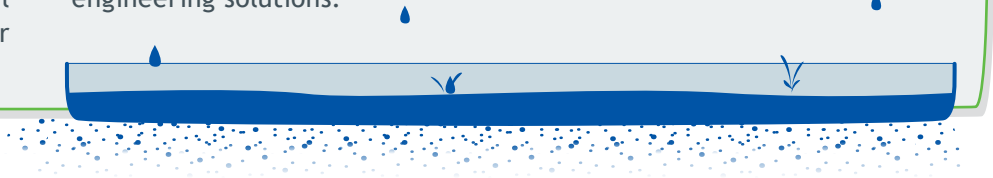
RETAIN
RAINWATER!

Increasing the water retention capacity in catchment areas is a key element in the management of heavy rain risk and flood risk in general. The message is simple: "keep the rain where it falls"! However, due to human influence, natural water retention capacity of catchments has decreased and runoff has accelerated in the past.

In the RAINMAN-Toolbox, you can find information about water retention measures, as well as links and downloadable material with more detailed, country specific information, recommendations and good practice examples for reasonable storage designing and management addressed to property owners, municipalities and farmers.

What can be done to 'keep the rain where it falls' even though it rains heavily?

- When planning retention measures, **consider influencing parameters, which are shaping the runoff**: these can be the land form, the surface permeability and soil characteristics, vegetation cover and weather conditions.
- **Profit by innovating with nature:** Often a complex of small retention measures has the same or a better effect than 'big' conventional engineering solutions.
- **Make use of integrated approaches,** get various stakeholders on board and consider climate change.



OUR STORY FROM KUNHEGYES, HUNGARY: Building a reservoir to protect the city

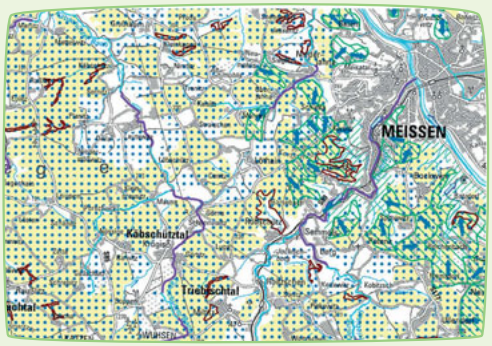
"A reservoir (a channel) was built in 2019 to primarily prevent the territory of Kunhegyes, from being flooded. The reservoir decreases the peak of river flood and gathers the excess water faster from the catchment without inundations. It can store more than 12.000 m^3 water above the standard volume from the sub-catchment; its length is 550 m. The depth of the water in the storage area can reach 2 m. This amount of excess water can also be retained after rainy periods, to mitigate the effects of drought, and to refill ground water sources. Thus, the investment also reduces other negative effects of climate change."

Gábor Harsányi, Middle Tisza District Water Directorate (KÖTIVIZIG), HU

ADAPT
SPATIAL PLANNING!

Spatial planning has the task to coordinate competing land uses and conflicting objectives and to identify and promote multifunctional land use potentials. Integrating goals for heavy rain risk reduction, spatial planning can be a powerful tool for reducing risks locally and even regionally. Possibilities for the implementation of risk reduction measures in spatial planning highly depend on the specific legal situation in the respective country and region. Here, the toolbox offers an overview and gives insights from different perspectives.

- Integrate water-sensitive urban planning in new developments: An early consideration of flood prevention is worthwhile!
- Consider synergies and conflicting objectives: Heavy rain risks are only one possible environmental risk.
- Adapt the local and regional planning levels to heavy rain risks as these are the levels particularly affected.
- Coordinate sectoral strategies into an integrative spatial development strategy. Make use of formal and informal instruments for your strategic planning and adaptation to heavy rain risks.
- Review spatial planning decisions on a regular basis.
- Keep your planning flexible for changing conditions (e.g. climate change) in order to reduce the vulnerability of regions and settlements.
- Establish appropriate cooperation and coordination mechanisms for the implementation of measures.
- Work towards securing resources and finances to ensure the implementation of your set goals.



OUR STORY FROM SAXONY, GERMANY: **Integration of heavy rain risk management aspects in the Upper Elbe Valley/Eastern Ore Mountains Regional Plan**

"Hardly any models exist in Germany for considering heavy rainfall events at regional level. In the region of Upper Elbe Valley/Eastern Ore Mountains a simplified risk assessment in the form of area prioritisation was carried out. Settlement areas, traffic routes, water bodies and regional priorities for river restoration downstream of run-off paths and steep slopes were taken into account. We can conclude that, when cooperating with specialist authorities and scientific institutions, regional planning can establish a framework for effective measures to reduce water erosion."

Michael Holzweißig, Regional Planning Authority Upper Elbe Valley/Eastern Ore Mountains, DE

ORGANISE
EMERGENCY RESPONSE!

In the RAINMAN-Toolbox, the section on emergency response addresses local and regional authorities who are in charge of setting up emergency response plans to minimise risks caused by heavy rain events.

Here you find a manual on how to create an emergency response plan for heavy rain events following a 3 step-approach:

STEP 1

REVIEW THE EXISTING HAZARD ANALYSIS

STEP 2

REVIEW THE EXISTING VULNERABILITY ANALYSIS

STEP 3

DEFINE SUITABLE MEASURES

It is applicable for different countries, administrative structures, geographical conditions and available hazard and risk information. To facilitate performing the single steps, you are asked to answer specific questions, carry out certain tasks, create certain documents and involve stakeholders. Provided templates and a catalogue of potential emergency measures support you to successfully carry out this work. An emergency response plan for heavy rain events will be the result of your efforts.

OUR STORY FROM GRAZ, AUSTRIA:

Setting-up an emergency response plan for selected hot spots in the city

"With its many water bodies, hillside locations and sewer system the city of Graz is living with complex flooding risks. RAINMAN took up the challenge and worked together with the city's stakeholders on improving heavy rain preparedness. As a starting point, a "heavy rain risk check" showed how well the City of Graz is prepared for pluvial flood events. A combination of scientific contribution and practical application was used for the assessment and mapping of heavy rain risks for five selected study areas in the city. To derive right conclusions for heavy rain preparedness, we developed in a first step a general toolkit for emergency response planning. The toolkit was then applied for the five study areas. As a result, specific action plans and an improved alarm and warning system are now available."

Cornelia Jöbstl, Office of the Styrian Government, AT

IMPROVE
EARLY WARNING!

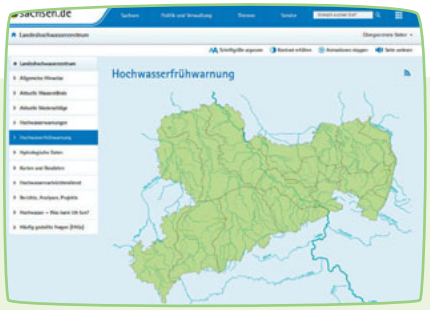
Heavy rain early warnings increase flood preparedness and can lead to a substantial reduction of damages in case of heavy rain and flood event. Such warnings can save precious time to take precaution measures. But early warnings alone do not keep hazards from turning into disasters. It needs entire warning systems for enabling individuals at risk, communities and organisations to prepare and act appropriately — in advance and during impending hazard events.

Local authorities are recipients but also re-distributors of heavy rain / flood early warning information. Therefore, the RAINMAN-Toolbox provides information to municipalities on how to access and interprete early warning information as well as on how to disseminate them further to potentially affected recipients. They can find an overview on existing early warning systems in European countries.

Private persons find here some useful advice on how to receive warnings and what to do then.

Within an early warning system, the core role of the local administration or competent authority is to:

- **Built-up sufficient response capabilities for the area,**
- **Strengthen the capacity of individuals at risk and other local key actors to receive, analyse and act-on incoming warnings,**
- **Enhance/complement existing early warning systems by local data,**
- **Improve existing early warning systems by feedback to system developers.**



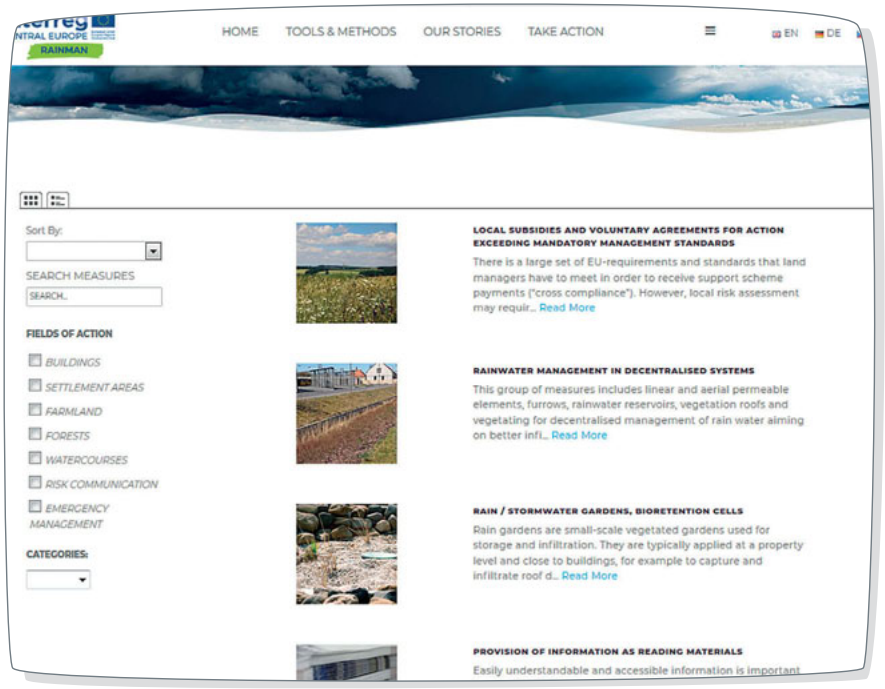
OUR STORY FROM SAXONY, GERMANY: Developing a flash flood early warning system

"Designing and implementing an early warning system is a long-term process and requires a lot of effort in making the end users familiar with the provided information. Target group oriented communication and training of the recipients of early warning information is probably the most important task when establishing an early warning system in an area."

Florian Kerl, developer of the Saxon flash flood early warning system, Saxon State Office for Environment, Agriculture and Geology, DE

SELECT
SUITABLE MEASURES!

Various measures can contribute to the mitigation of heavy rain risks. In the RAINMAN-Toolbox a collection of 100 risk reduction measures is available that combines existing catalogues of all RAINMAN partner countries as well as knowledge and experiences made in the project. It provides a variety of measures ranging from structural to non-structural measures and covering different fields of action like settlement areas, buildings, agriculture, forestry or communication.



Link to the "Catalogue of 100 risk reduction measures":
http://rainman-toolbox.eu/home/tools-methods/risk-reduction-measures/catalogue-of-measures/

OUR STORY FROM SAXONY, GERMANY:

Improving water retention by adaptation of farming practices in Spitzkunnersdorf

"After a heavy rainfall event in 2017 with big damages on farmland and in the village, the local agricultural enterprise in Spitzkunnersdorf decided to adapt its farming practices in order to increase infiltration capacity of the compacted soil and to prevent erosion. The avoidance of ploughing, intense mulching, adapted field division and strip till practices have already improved the water retention capacity of the ground. These are only some of the experiences that were contributed to the catalogue of 100 measures!"

Dr.-Ing. Sabine Scharfe, Saxon State Office for Environment, Agriculture and Geology, DE

3. OUR STORIES

We consider it essential to take into account the needs and requirements of local practice!

We built on an extensive theoretical knowledge base from six Central European countries: in exchange with stakeholders from municipalities and regional authorities, our tools, methods and measures were tested and implemented in our pilot activities.

Find the RAINMAN pilot regions on the map of Central Europe, find out more on the following pages or browse through our good practice examples to get to know our stakeholders and our stories.

Saxony, Germany
Lower Silesia, Poland
South Bohemia, Czech Republic
Upper Austria
Graz, Austria
Zagreb and Umaški potok, Croatia
Tiszakécske and Kunhegyes, Hungary

LOCATIONS
- City of Meissen
- Municipalities of Oderwitz and Leutersdorf (district Spitzkunnersdorf)
- Other locations

ACTIVITIES
- Assessment and mapping
- Risk reduction measures
- Risk communication

AREA TYPE
- Urban, semi-urban, rural, agricultural

LAND FORM / TERRAIN
- Flatland, hilly, mountainous

In Saxony, four associated partners supported the RAINMAN consortium with their local knowledge and experiences in heavy rain mitigation. Together with the City of Meissen, the municipalities of Oderwitz, Leutersdorf (district Spitzkunnersdorf) and other locations, we tested and validated specific heavy rain risk management approaches in the fields of risk assessment and risk reduction measures.

The participating municipalities were hit by heavy rain events with immense damages. After these events the communities planned and implemented a large number of construction measures against flash floods along the rivers.

With intensive support of RAINMAN different activities were taken up, from risk mapping, risk reduction as well as raising risk awareness. In Meissen, for example, hydrodynamic simulations and flow path analyses were conducted. In Oderwitz and Leutersdorf, the focus laid on risk communication measures and measures for the improvement of emergency response.

OUR STORY
IN LOWER SILESIA, POLAND

LOCATION
- Lower Silesia
- Zgorzelec county
- Czerwona Woda catchment

ACTIVITIES
- Assessment and mapping
- Risk reduction measures
- Risk communication

AREA TYPE
- Urban, semi-urban, rural, agricultural

LAND FORM / TERRAIN
- Hilly, lowland

In Poland, the Institute of Meteorology and Water Management — National Research Institute together with the associated partners (Institute for Territorial Development and Polish Waters in Wrocław) supported the RAINMAN project in testing and developing a methodology for hazard maps (vulnerability to flash flood hazard and vulnerability to soil water erosion), analysing good practices to reduce the risk of heavy rain and developing a contribution of the concept of retention and the catalogue of corrective actions and action plans in the field of spatial planning.

Interactive lessons were developed for use at school workshops, based on information gathered in a survey of the territory at several interested schools. Moreover, cooperation to raise awareness about climate change and extreme phenomena, with particular emphasis on heavy rains, was implemented at local, regional and international level.

IN SOUTH BOHEMIA, CZECH REPUBLIC

LOCATIONS
- Popelín
- Písek
- Lipí
- Strakonice

ACTIVITIES
- Risk communication
- Risk reduction measures

AREA TYPE
- Semi-urban, agricultural

LAND FORM / TERRAIN
- Hilly

The South Bohemian Region in close cooperation with the Research Institute of Water Management T. G. Masaryk, v.v.i. (VÚV) tested the jointly developed RAINMAN methods and tools in order to achieve the maximum reduction of negative impacts of pluvial floods, especially on built-up areas. The South Bohemian Region studied the integration of flood control measures into land use plans. The cooperating partners analysed the territory and identified "collision points", proposed risk reduction measures, assessed which measures need to be addressed in the spatial plan and verified whether the spatial plans of the municipalities allow the implementation of the proposed solutions or whether they need to be changed.

The study focused on four pilot sites in the South Bohemian Region. It was preceded by a terrain reconnaissance. Field investigations and meetings with municipal representatives, in particular with mayors, accompanied the work.

OUR STORY IN UPPER AUSTRIA

LOCATIONS
- Kraims/Seewalchen
- Leonding
- Poneggen/Schwertberg

ACTIVITIES
- Assessment and mapping
- Risk reduction measures

AREA TYPE
- Rural, agricultural

LAND FORM / TERRAIN
- Hilly

Past heavy rain events as recently as in 2019 have led to significant damages in agricultural and rural settlement areas in Upper Austria. The regional administration of Upper Austria has recognized the need of a coordinated approach and targeted action to effectively reduce and mitigate possible damages.

Therefore, the Environment Agency Austria jointly with the Office of the Upper Austrian Provincial Government tested and assessed different methods for risk assessment and mapping. Heavy rain tests in Seewalchen and Leonding illustrated the process of the generation of surface flow on agricultural sites. Differerent up-to-date hydrodynamic simulation models for heavy rain were tested to study their sensitivities: effects of different mesh densities, terrain model accuracies, variations in surface roughness and discharge coefficients in Seewalchen showed effects on flow paths and water depths; effects of walls and culverts were investigated in Schwertberg. Risk mitigation by structural measures and applicability of cost-benefit analysis were tested in Seewalchen. The close cooperation between science and administrative practice delivered up-to-date results which are documented in the Upper Austria Pilot Study Report. The very essence is condensed in the guidance for hydrodynamic simulations of surface flow.

LOCATIONS
- City of Graz

ACTIVITIES
- Assessment and mapping
- Risk reduction measures
- Risk communication

AREA TYPE
- Urban

LAND FORM / TERRAIN
- Hilly

The Office of the Styrian Government and the City of Graz continued their long-established close cooperation regarding flood risk management within the RAINMAN project.

The City of Graz suffered from several pluvial floods, the last occuring in 2018. Due to a high number of urban streams and the urban sewer system heavy rain events in Graz need to be considered as combined flood events.

A joint analysis of the special challenges in heavy rain risk management in Graz laid the foundation for the development of RAINMAN activities to improve the preparedness of the City of Graz.

The focus was set on developing and testing risk management approaches regarding risk assessment and mapping, risk reduction measures and awareness raising. The active involvement of institutions in charge in heavy rain risk management was specifically considered to ensure the up-take of the results for future actions.

OUR STORY
IN ZAGREB AND UMAŠKI POTOK, CROATIA

LOCATIONS
- Zagreb
- Umaški potok

ACTIVITIES
- Assessment and mapping
- Risk reduction measures
- Risk communication

AREA TYPE
- Urban, semi-urban, agricultural

LAND FORM / TERRAIN
- Hilly, lowland

In Croatia, two pilot actions (Zagreb and the river basin of Umaški potok, in Istria) were realised.

In Zagreb, heavy rain events pose a threat to the urban environment due to topographic conditions. Activities in the pilot area included assessment and mapping activities, the development of risk reduction measures and improvement of risk awareness and communication.

In the river basin Umaški potok, heavy rain events lead to severe floods due to a complex run-off system as well as the sea level fluctuations. Faced with climate change and rising sea levels, prevention for future damages of heavy rain events is essential. Therefore, a risk analysis including the development and improvement of a flow model was carried out which serves as information basis for emergency services and local authorities.

IN TISZAKÉCSKE AND KUNHEGYES, HUNGARY

LOCATION
- Tiszakécske
- Kunhegyes

ACTIVITIES
- Assessment and mapping
- Risk reduction measures
- Risk communication

AREA TYPE
- Semi-urban, agricultural

LAND FORM / TERRAIN
- Flatland

In Hungary, the average annual precipitation shows extremely high territorial and temporal variability as the country is influenced by three climatic zones (continental, oceanic, mediterranean). Under such conditions a considerable part of precipitation is lost by surface runoff, downward filtration and evaporation.

The excess water is a form of temporary water inundation that occurs on flat lands due to extreme precipitation, sudden melting of snow, and high groundwater level, which can emerge on the surface. Especially in the flatland regions the excess water causes problems and damages in agricultural areas. Damage caused by excess water can affect up to 60% of the arable land in Hungary. To reduce the risk of heavy rain damages, a method to assess the heavy rain risk mapping of flat lands and a hazard and risk map were developed. Based on these, risk reduction measures, such as the construction of the Kakat reservoir, were undertaken to prevent damages of future heavy rain risk events.

PICTURE SOURCES

Front and back page photo, p. 6: pixabay; p. 1: Saxon State Office for Environment, Agriculture and Geology, Germany; p. 4: INFRASTRUKTUR & UMWELT Professor Böhm und Partner; p. 7: Environment Agency, Austria; p. 8: Axel Sauer, Leibniz Institute of Ecological Urban and Regional Development, Germany; p. 9: from top to bottom: Institute of Meteorology and Water Management-National Research Institute (IMGW-PIB), Poland; Hrvatske vode, Croatia; T. G. Masaryk Water Research Institute, Czech Republic; Middle Tisza District Water Directorate (KÖTIVIZIG), Hungary; p. 10: Institute of Meteorology and Water Management-National Research Institute (IMGW-PIB), Poland; p. 14: T. G. Masaryk Water Research Institute, Czech Republic; p. 15: Middle Tisza District Water Directorate (KÖTIVIZIG), Hungary; p. 16: 2nd overall update of the Upper Elbe Valley/Eastern Ore Mountains Regional Plan (draft statutes not yet approved), https://rpv-elbtalosterz.de; p. 17: Lebensressort Land Steiermark / honorarfrei, Austria; p. 18: Screenshot from the Saxon Flood Centre web page / www.hochwasserzentrum.sachsen.de; p. 19: Sabine Scharfe, Saxon State Office for Environment, Agriculture and Geology, Germany; p. 21: Daniel Schäfer, 2017 [M]; p. 22: Institute of Meteorology and Water Management-National Research Institute (IMGW-PIB), Poland; p. 23: Jihočeský kraj, Czech Republic; p. 24: Universität Innsbruck / Bundesforschungszentrum für Wald, Austria; p. 25: Bernhard Egger-Schinnerl, Stadt Graz, Abteilung für Grünraum und Gewässer; p. 26: Hrvatske vode, Croatia; p. 27: KÖTIVIZIG, Hungary - title: inland excess water near to Kunhegyes