BINGO
a better future under
CLIMATE CHANGE

BRINGING INNOVATION TO ONGOING
WATER MANAGEMENT

Guidelines

Performing risk assessment

May 2019

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The BINGO project has received funding from the European Union's Horizon 2020 Research and Innovation programme, under the Grant Agreement number 641739.

Horizon 2020 Societal challenge 5:
Climate action, environment, resource efficiency and raw materials

BINGO

Bringing INnovation to onGOing water management – a better future under climate change

Grant Agreement n° 641739, Research and Innovation Action

Short Summary

The evolution of climate changes still presents large uncertainty. Water is the central resource in BINGO and how its excess or deficit affects key socio-economic services is the key issue addressed in the project. Adaptation strategies require decision under uncertainty, what is a difficult task by people in charge, no matter its ranking position (policy makers, regulation entities, service provider entities, citizens).

Adoption of an adaptation strategy requires knowledge about a large diversity of information regarding natural or environmental phenomena; conditioning factors influencing the adaptation objectives (political, social, economic, technological, organizational) affecting the socio-economic key activities; relevant actors, perception of risk, etc.

A risk management approach is a suitable methodology to link all this information and structure it in a way able of providing support to decision making.

This report provides guidelines to develop the most relevant steps of a risk assessment process, based on ISO: 31000, referring to BINGO experience and their limitations and successes. It aims at being useful to any type of entity performing the first attempt of a risk management process.

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1. INTRODUCTION

Although no doubts exist that we are facing climate changes, its evolution still presents large uncertainty. Water is the central resource in BINGO and how its excess or deficit affects key socio-economic services is the key issue addressed in the project. Adaptation strategies require decision under uncertainty, a difficult task by people in charge no matter their ranking position or sector of society (policy makers, ministries, regulation agencies, planning agencies, service provider entities, private sectors entities, technicians, citizens).

Establishing an adaptation strategy requires knowledge about a large diversity of information, either natural or environmental (climate, hydrological, etc.) or about political, social, economic and technological factors affecting the socio-economic key activities (public water supply, agriculture water supply, tourism, people safety protection, etc.), and how they are affected.

A risk management approach is suitable to support decision under uncertainty, interlinking all the above referred information. Risk management is the process, distinct from risk assessment, of weighing policy alternatives, in consultation with all interested parties, considering risk assessment and other factors relevant for the protection of people, activities or sectors under analysis, and, if needed, selecting appropriate prevention and control options.

Risk assessment, as part of the risk management approach, was implemented in BINGO at all research sites in work package 4 (WP4), interlinking the climate change predictions produced in BINGO WP 2 with the impacts on water bodies (estimated in WP3), with the specific key vulnerabilities of the socio-economic activities addressed at each research site and with the acceptable tolerance of risk, among other aspects. It intended to support decision for risk reduction, to be achieved in BINGO WP5.

The guideline presented in this report is part of the BINGO exploitation strategy and is designed to help stakeholders that do not still have a risk culture embedded in their procedures to adopt an easy methodology to support decision, by providing the example pursued by BINGO and the road map followed.

2. METHODOLOGY

When addressing climate changes, risk is associated with the interaction between environmental phenomena, communities and the surrounding environment. If there is no interaction between environmental phenomena and the human community or surrounding environment there is any risk associated. When interaction occurs, the environmental phenomena then can become a hazard (Figure 2.1).

Figure 2.1: Risk requires interaction between environmental phenomena, communities and the surrounding environment

Risk is defined as the effect of uncertainty on objectives of an entity (organization, individual, etc.) therefore risk management is decision under uncertainty. Risk (*R*) is expressed in terms of a combination of the consequences of an event (*C*), or a change in circumstances, and the associated probability of occurrence (*P*) (Figure 2.2). The terms susceptibilities and resilience are usually used within a disaster risk management (DRM) approach, common in floods risk management, and sensitivity and adaptation are usually used within a climate change approach, common in droughts and water resources shortage management.

R = P X C

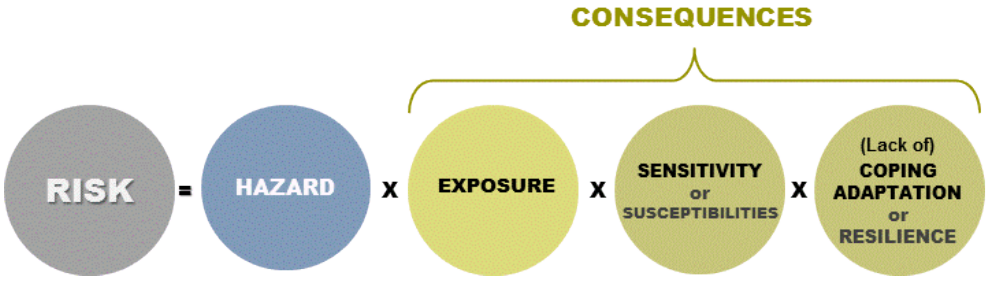


Figure 2.2: Risk concept (ISO 31000:2009) where risk is expressed in terms of a combination of the consequences of an event and the associated probability of occurrence

Thus, to identify risks, it is necessary to take into account the ***nature of the hazard*** and the ***factors*** that affect the consequences or impacts over the human elements and its surrounding environment. Therefore, a social based approach is required for the framework, in order to answer to questions as:

- What can happen?
- If it happen what will be the consequences?
- Is it likely to happen?
- What is the level of risk?
- What level of risk is acceptable and what level of risk is intolerable?
- What actions can we take to reduce the risk?
- Who is responsible for taking action?
- What resources do we need?
- What do we know to take decision? What do we not know?
- For which period of time are we adapting?
- When is it worthwhile to implement the necessary risk reduction measures?

In BINGO, it was implemented a risk assessment procedure based on ISO 31000:2009, as part of a comprehensive risk management framework, that includes several key steps (Figure 2.3), each of them with a significant purpose (Figure 2.4):

- Establishment of the **context** for the risk management process (RMP);
- **Risk assessment,** comprehending:
    - risk identification;
    - risk analysis and
    - risk evaluation;

- Risk **treatment;**
- **Communication** and **consultation;**
- **Monitoring** and **review.**

The outcome of risk assessment will assist risk decision about risk treatment strategy (reduce, avoid, transfer, accept) and design (measures adopted).

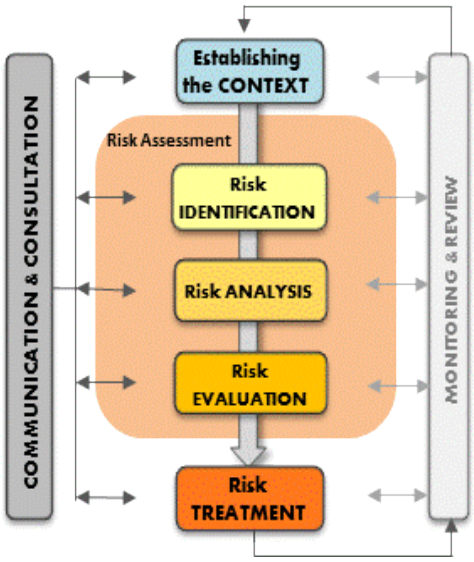


Figure 2.3: Risk Management Process (ISO 31000:2009)

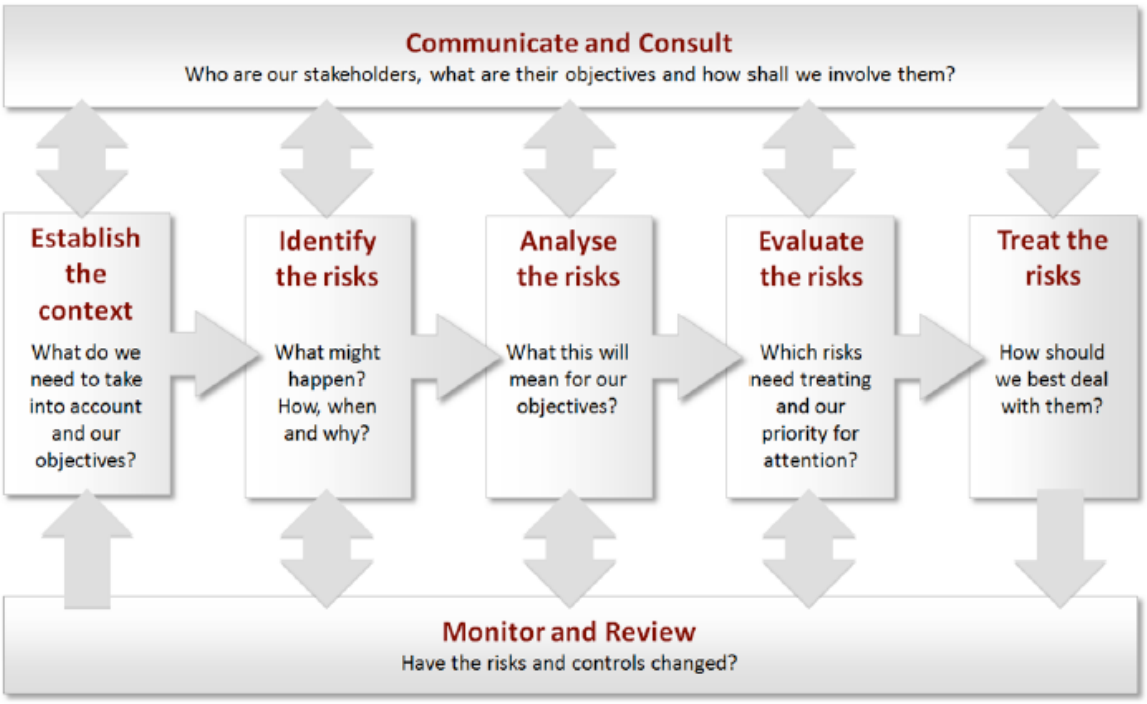


Figure 2.4: Purpose of each step of the Risk Management Process (Broadleaf, 2012)

As very relevant output it can be also stated that a risk management approach structures all the necessary information to answer the right questions, enabling informed decision for suitable risk reduction solutions.

The main output of risk assessment, as part of a risk management process, is risk prioritization.

Risks have two sources: i) hazard sources, related to the triggers (climatic, or other), and ii) those associated with the elements exposed (physical, social, economic or other) and how they respond to the hazardous phenomena, giving rise to an event with undesirable consequences.

When referring to risk ranking it is usually assumed as ranking risks related to different hazard sources (e,g. extreme precipitation, earthquake, market change, etc.) but, in fact, the hazard under study can be only one (e.g. water resources shortage due to a severe drought).

In this last case, risk ranking is about ranking exposed elements responses, regarding how they individually compromises the established objectives, or about ranking vulnerabilities, related either with intrinsic vulnerabilities of the elements exposed or with context fragilities. They all enable adaption strategies design (risk treatment).

A risk management approach is suitable for all levels of decision, from national to local policy making, to communities' management, organizations (public services, economic activities, etc.) or individuals. The level of output is naturally different.

BINGO project focused on effects of climate change, as driving force, on people and property safety and on key water dependent human activities. The extreme climatic phenomena with potential to become a hazard were related with the excess or shortage of precipitation and with estuarine storm surges and spring tides, depending on the case study addressed. When dealing with reduced precipitation, the hazard addressed in the project was water resources deficit for public water supply, agriculture water supply, energy production and environmental sustainability to support touristic activities. For phenomena of intensive precipitation, the concern relied on inundations due to urban drainage combined sewer overflow or to river flooding, with potential to harm people and economic assets or socio-economic activities, as for example tourism related activities. When focusing on storm surges and spring tides the hazard was inundation of agricultural land, by water with high salt content.

Although addressing different hazards and their impacts on people and property safety or on socio-economic water dependent activities the risk approach methodology to assess the risk was the same. Whether focussing on an economic sector (e.g. agriculture), a public service (e.g. public water supply), or avoiding society disruption, questions addressed are similar:

In BINGO, some case studies performed a risk management process from the point of view of a water authority (risk owner), responsible for managing and allocating water for several uses, while others performed it from the point of view of water supply entities or irrigation associations, both managing water sources as raw material, both dependent from water allocated for their respective uses. These cases represent sequential levels of a chain of water management and uses. Some other cases dealt with entities responsible for urban water drainage management (municipal level), responsible for avoiding inundations or contamination of the recipient water bodies, with impact on leisure and tourism.

Bridging environmental impacts with socio-economic impacts in order to develop strategies to improve adaptation and resilience is a multidisciplinary job, requiring a multidisciplinary team. BINGO research site teams struggled with some lack of multidisciplinary diversity, and some difficulties existed in understanding and implementing some concepts. These difficulties were, in fact, a reflex of real life, once the majority of stakeholders of the project do not have a risk culture embedded in their organizations and a risk approach was still new for most of the organizations involved in the project. In order to overcome the existing difficulties, guidance was developed to support implementation of key steps along the project.

A risk management process should be framed by a risk management framework that (Figure 2.5):

1. provides the foundations necessary to assist **integrating risk assessment into CC adaptation**, by providing means to evaluate and prioritize risks to support decision-making, strategies definition and inter-sectorial conflicts management;
2. assists to establish internal and external **reporting and communication mechanisms** to facilitate communication among risk managers, stakeholders, technicians, scientists, decision-makers and all other intervenient in the process.

Figure 2.5: Risk Management Framework (WHO, 2010)

This Organization's risk management framework should be developed prior to any risk management process. It includes: the organization's *context* (the external and internal context of the entity responsible for dealing with risks under study); a*ccountability* (governance over the risk management process must be clearly identified: assign accountabilities, authority and competence for managing risk at appropriate levels); *risk management policy* (clearly stating the organization's objectives for, and commitment to, risk management, including links between the organization's objectives and policies and the risk management policy, the way in which risk management performance will be measured and reported, etc. (Figure 2.5); communication and *consultation* plan of the organization (how to communicate and consult will be reflected in each step of the RMP) and *resources* (ensure the necessary resources available to assist those accountable and responsible for managing risk: human, financial, technological, …).

Chapter 3 presents some guideline and tips to perform a successful risk assessment process. These are not full comprehensive guidelines and more references should be consulted to obtain an in-depth insight of the process. The ISO 31000:2009 and its implementation manual (ISO, 2009a) are essential. The guidelines produced for BINGO development can also contribute to understand and implement the main steps (Rocha, 2016 and Rocha, 2017). The establishment of the comprehensive organization's risk management framework will not be addressed in these guidelines.

Figure 2.6 summarises the methodology implemented, adapted to the project from ISO 31000:2009, framed by a communication and consultation strategy.

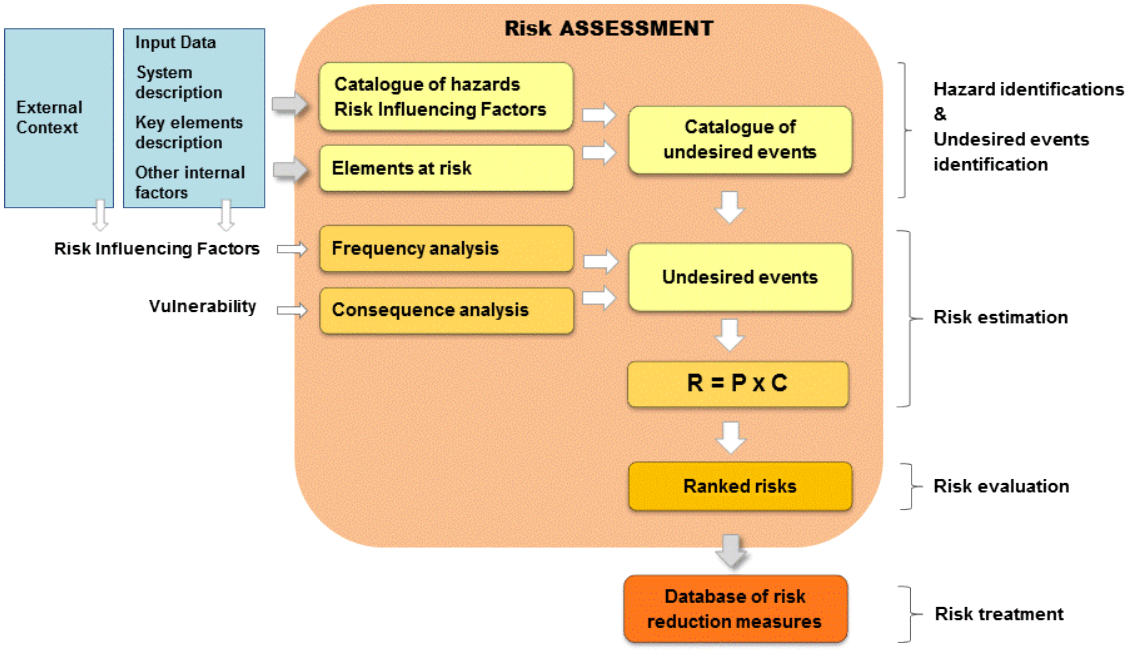


Figure 2.6: Framework for risk assessment developed in BINGO, adapted from ISO 31000:2009

The output of a risk assessment process should be very structured, clean and straightforward.

As experience to perform a risk management process increases, the simplest and cleaner becomes the output, simply because the unessential information is purged and relationships become more understandable, as for example between external factors and consequences, or between intrinsic vulnerabilities and consequences. Outcomes should be as much as possible of tabular, flowchart or diagram forms, easy and fast of reading and understanding.

3. GUIDELINES

This guideline addresses the steps necessary to accomplish risk assessment, as part of a risk management process. These steps are the following:

Step 1: Communicate and consult

Step 2: Establish the context for the risk management process (RMP)

Step 3: Risk identification

Step 4: Risk analysis

Step 5: Risk Evaluation

Step 1: Communicate and consult

Risk owner (person or entity in charge of the risk management process - RMP) aims to identify and engage the appropriate internal and external stakeholders and ensure an effective exchange of information among the relevant intervenient (Figure 3.1).

1. • Assemble Team → Identify and engage the appropriate internal and external stakeholders and understand their accountabilities within the risk management process;
2. • Establish the communication and consultation plan: Identify relevant issues to communicate to and consult stakeholders, including intents and priorities, objectives and perception of risk

Figure 3.1: Main points of communication and consultation plan

Risk owner: individuals, a system or an organization, the environment or the community, in charge of performing the risk management process.

Stakeholder: Person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or activity. A decision maker can be a stakeholder.

This step is crucial for the success of the risk assessment process. Some stakeholders may be reluctant of being involved.

Dealing with uncertain and how to respond is a difficult task. Discussion and debate are likely to lead to a greater shared understanding of the:

- causes of the problem;
- problem itself (problem formulation);
- risks and vulnerabilities;
- values at stake (for risk judgement → risk tolerance);
- range of possible responses.

In order to be successful, engagement of stakeholders must obey to certain requisites. Three key questions must be addressed in the early phase of establishing a programme of community engagement (Bell *et. al.*, 2017):

- Who should participate?
- What do we already know about the community?
- How should participation proceed?

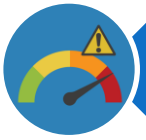
Some questions help to identify where to position engagement at various steps, and how to identify stakeholders and participants:

- What is the nature of the decision?
- What is the purpose or goal of the engagement?
- How diverse are the community and stakeholder values?
- How are the potential impacts distributed?

Engagement activities should:

1. be in line with the guiding principles
2. suit the target group(s)
3. fit the stage of the 10-step decision cycle and achieve the outcomes desired for that step, as well as contribute to the process as a whole.

In BINGO some of the relevant stakeholders were partners of the project. In some cases they were not project partners but they integrated the research site's Community of Practices (CoP). In other cases, relevant stakeholders were neither project partners nor engaged in the CoP, what raised some difficulties.



Step 2: Establish the context for the risk management process (RMP)

Before beginning a risk assessment procedure, it is important to define the limits, objectives and scope of the activity or issue under examination. The context concerns what is needed to be taken into account and the objectives. Figure 3.2 summarises the main points to be considered.

The CONTEXT for the Risk Management Process is Activity/ Process oriented.

The context concerns what is needed to be taken into account and the objectives when managing the risk.

1. Clear definition of the **goals and scopes** of the risk management activity
2. Identification of the **external** and **internal** factors to be taken into account when managing risk (*external and internal context for the RMP*);
3. Sets the **scope** and **risk criteria** for risk assessment
4. Structures the **methodology** of risk analysis

Figure 3.2: Main points of the Risk Management Process's Context

1. Clear definition of the goals and scopes of the risk management activity

In the context, risk owner restricts the risk management framework to a specific part or activity of the Organization that will be the object of the risk management process (RMP). As an example, a water supply entity covers several components of the supply system (water sources, water treatment, water transport and distribution). In BINGO, it were considered the components affected by climate change, therefore only water sources were considered and, in some cases, water treatment, as raw water quality can change under extreme climate events. *The clear articulation of specific goals* is very important for the risk management development.

2. Context of the RMP process (external and internal factors to be taken into account when managing risk)

The establishment of the RMP's context influences directly the formulation of the problem (objectives and specific scopes), as well as the structure of risk analysis and risk evaluation (risk tolerance criteria). Figure 3.3 intends to illustrate how key influencing factors, identified in the RMP's context, can influence not only the problem formulation (objectives setting) but also the risk tolerance levels, according to risk owner and stakeholders views, or even due to binding legislation.

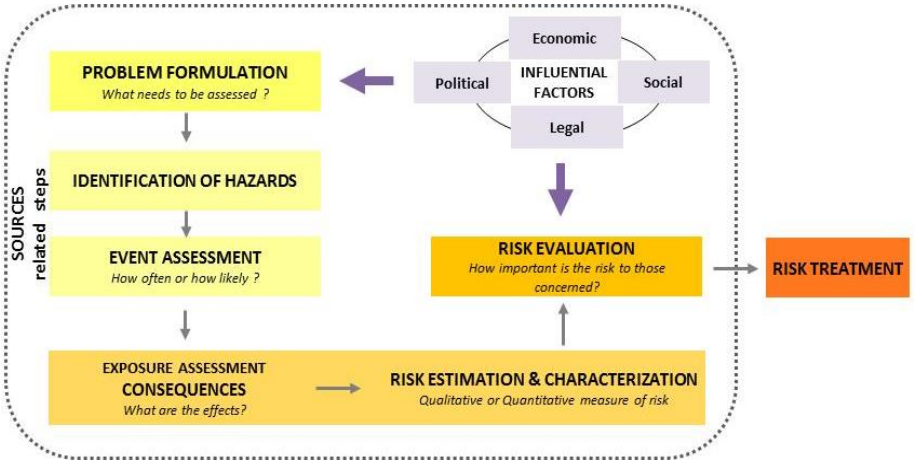


Figure 3.3: Relevance of context for the RMP (Adapted from Csaba and Nikolett, 2008 and Heinz, 2010)

For the ***external context*** it is suggested to follow a PESTLE approach or a combination of a PESTLE and SWOT analysis (Figure 3.4).

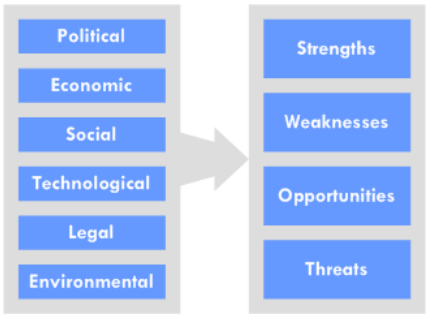


Figure 3.4: **PESTLE and SWOT analysis (Source: Jisc, 2016)**

PESTLE analysis intends to answer to questions of the sort:

- **Political -** What are the key political drivers of relevance?
- **Economic -** What are the important economic factors?
- **Social** - What are the main societal and cultural aspects?
- **Technological -** What are current technology imperatives, changes and innovations?
- **Legal -** Current and impending legislation affecting the role.
- **Environmental -** What are the environmental considerations, locally and further afield?

Internal context is anything within the Organization that can influence the way in which an Organization will manage risk. The purpose of this stage is to develop an understanding of the organization and its capabilities, as well as its goals and objectives and the strategies that are in place to achieve them.

3. Scope and risk criteria for risk assessment

Criterion: a standard of judging, any established la, rule, principle, value, etc., by wich a valid judgement may be formed.

Risk acceptance criteria: criteria used as basis for the decision about acceptable risk, during the risk assessment process, but essentially for risk evaluation step.

Tips for defining risk criteria

Risk criteria establish measures of risk significance; tolerance levels and views of stakeholders.

- Decide or define the acceptable level of risk for each activity;
- Determine what is unacceptable;
- Clearly identify who is responsible for accepting risk and at what level.

When doing so, remember:

- Do not define risk criteria that are not aligned with organization values and RMP objectives and context (external and internal);
- Define risk criteria simultaneously with scope's specific objectives;

- Align with the structure of risk analysis - for instance, do not provide qualitative levels of risk (risk analysis) and then have quantitative evaluation criteria (tolerance of risk);
- Risk criteria can be derived from standards, laws, policies and other requirements;
- At the initial step the risk criteria may be broadly defined and then further refined later in the risk management process.

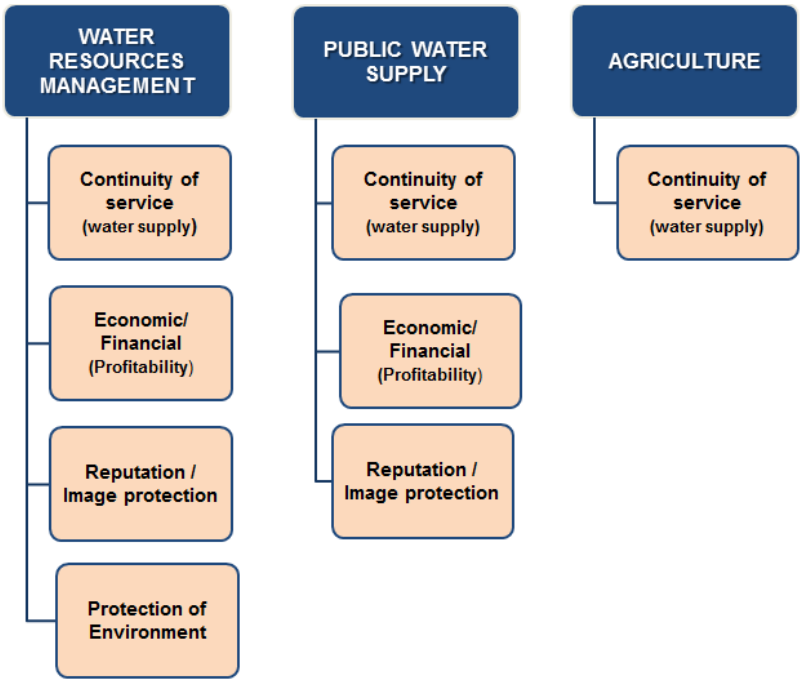
The context is an extremely important step of the risk management process. Setting the scope of analysis, identifying the relevant actors and their accountabilities, identifying the relevant risk influencing factors and setting the values or criterion of risk acceptance are crucial for the adaptation process.

BINGO addressed two types of hazards, water resources deficit and inundation, able of impacting the different socio-economic activities selected for the several research sites. Figure 3.5 illustrates the scopes of analysis selected for the BINGO research sites.

Establishing the context, mainly deciding upon the relevant factors able of influencing the consequences, proved to be quite challenging for BINGO research site teams. It was the beginning of the process and the risk approach was not already clear. Along the process understanding was gained. A very simple example how concepts were not clear at first relates to the objectives/ scopes definition. The last version of scopes presented in Figure 3.5 is far from the initial one. For example, environmental (water bodies) protection is an objective for water resources management entities but is a legal binding influencing factor (not an objective) for public or agriculture water supply. Other situation refers to the formulation of objectives that did not have an underling source of uncertainty affecting the objectives. That cannot be included in a risk management process, were management under uncertainty is the central reason for its implementation. Working and exchanging experiences proved to be quite efficient to overcome several initial doubts.

Other challenge was the establishment of the risk criteria, not only concerning the methodologies for risk analysis (how to estimate risk likelihood, assess consequences and estimate risk level) but also deciding upon risk tolerance. Being such an important issue tips are provided.

a) BINGO Hazard: Water resources deficit



a) BINGO Hazard: Inundations

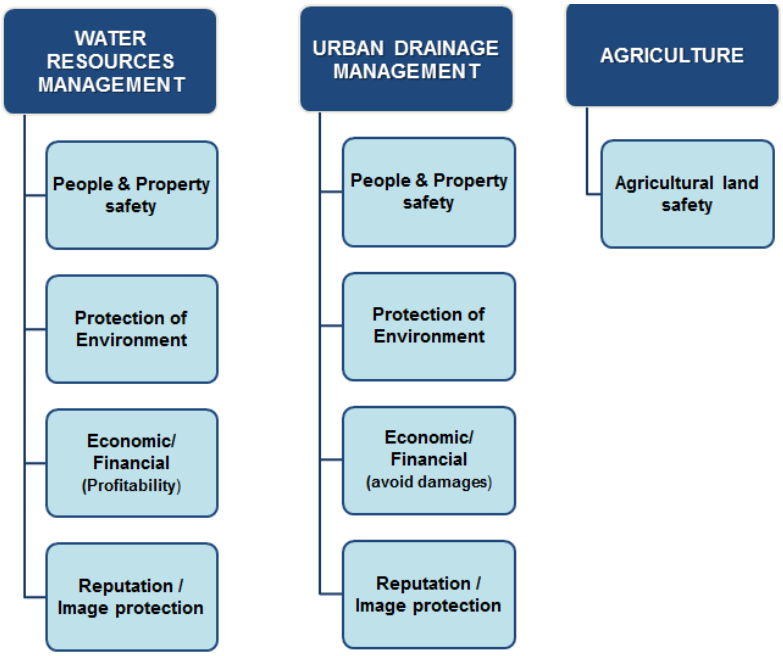


Figure 3.5: BINGO socio-economic activities and specific scopes of analysis addressed in the set of research sites' RMP for two different hazards.

Step 3: Risk identification

Risk identification (ISO 73:2009) is a process that involves *finding, recognizing, and describing the risks* that could affect the achievement of an organization's objectives**.** It is the process of identifying possible sources of risk, areas of impact, events, their causes (or sets of circumstances) and their potential consequences. An event can be a change in circumstances with potential to affect the achievement of objectives.

The aim of risk identification is to generate a comprehensive list of risks based on those events that might create, enhance, prevent, degrade, accelerate or delay the achievement of objectives.

Figure 3.6 identifies the main tasks of risk identification.

1. Task 1a: **Hazard identification**
2. Task 1b: **Risk influencing factors identification**
3. Task 2: **Listing of undesired events**

Figure 3.6: Main tasks of risk identification

Task 1: Hazard and risk factors identification

Task1 is about identifying relevant hazards, risk sources and risk factors and possible undesirable impacts. Positive impacts, resulting from opportunities, could also be considered, but for purposes of these guidelines, the focus will be in threats and negative impacts (losses or harm). Figure 3.7 explains the underlying concepts and illustrates the relation between risk sources and factors leading to a hazard, if exposure of human elements occurs.

Hazard source may not be the hazard itself. As an example, considering water supply for public or agriculture purposes, the reduction of precipitation is not the hazard but a hazard source. If it results in water resources availability insufficient to fulfil demand, then water resources deficit is the hazard. There's a pathway between precipitation and its hydrologic manifestation.

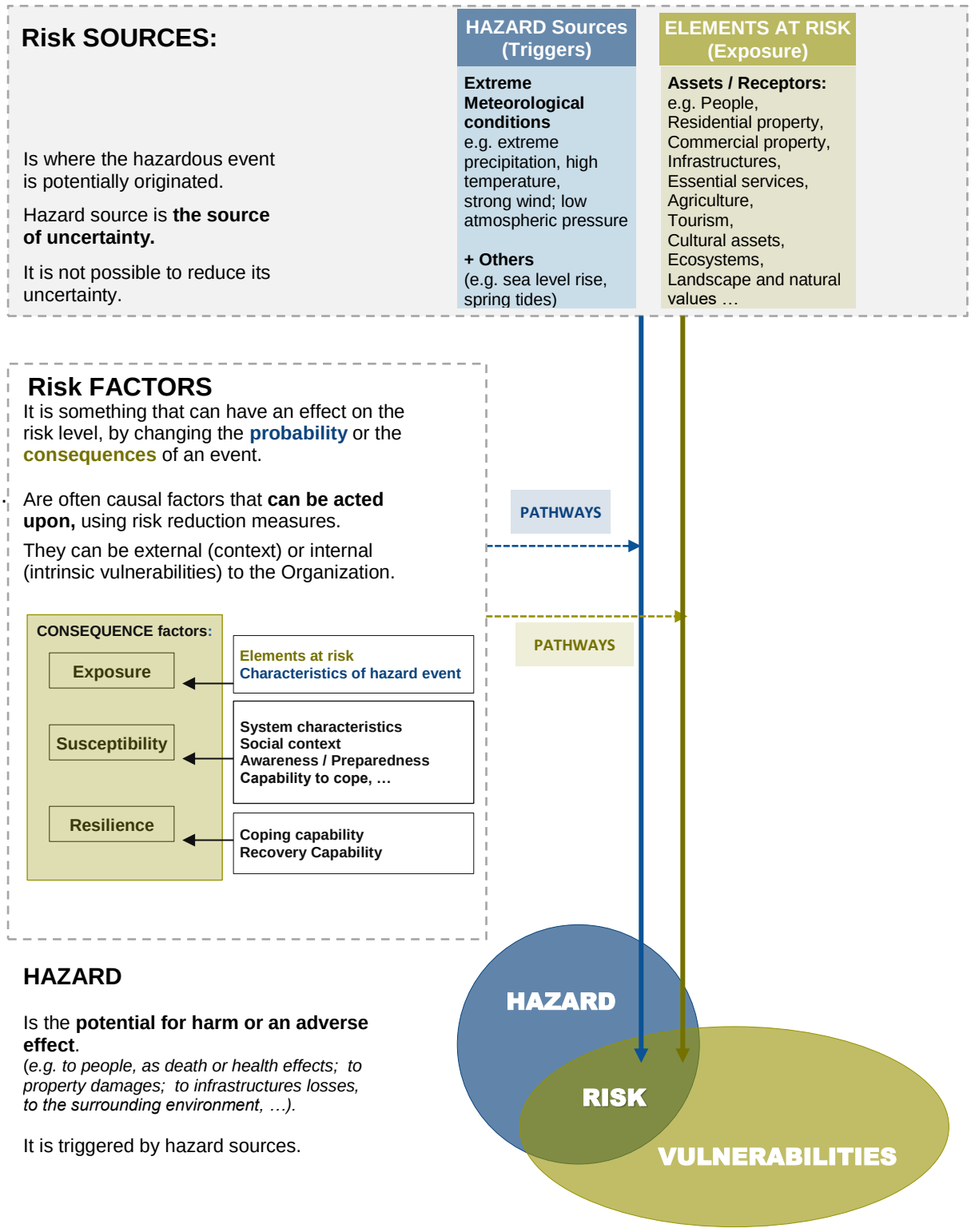


Figure 3.7: Task 1 - Identification of relevant hazards, risk sources and risk factors

It is important to distinguish between hazard source and risk factor. It is not possible to change the chance of a hazard source, in this case the extreme climatic phenomena (source of uncertainty), but it is possible to change the chance of occurring a water resources deficit, by increasing water resources availability (trough damming or other ways). Existence or inexistence of interannual regulation capacity is a risk factor that influences the pathway between precipitation and its hydrologic manifestation, affecting the resulting hazard.

Risk factors typically cover three main categories of elements exposed, namely: human factors; environmental factors; and physical factors. Vulnerability of human elements result of the range of economic, social, cultural, institutional, political and psychological factors that shape people's lives and the environment that they live in (Twigg, 2004).

Task 2. Listing of undesired events

The aim of ***task 2*** is to generate a comprehensive list of risks based on events that might create, enhance, prevent, degrade, accelerate or delay the achievement of risk management objectives. Besides identifying what might happen, it is necessary to consider possible causes and scenarios that show what consequences can occur (why and how). All significant causes and consequences should be considered (ISO, 2009b).

This step intends to identify why and how can it happen. This is accomplished by:

- Setting events (facts), and
- Identifying their causes (combination of hazard sources) and potential consequences (impacts on elements exposed and then consequences over the objectives of the risk management process).

Task 1 is an identification process, where impacts on elements exposed to the hazard are not explicitly addressed. No concrete situations are set in place. Task 2 moves forward, setting scenes (events). This task feeds the next step, risk analysis, that will assess the extent of consequences and the likelihood of these events and, hence, the level of risk.

Tips

When selecting events take into consideration the following:

- An event is only a risk if there is a degree of uncertainty associated with it;

- A natural hazard is a threat (or source) of a naturally occurring event only if it will have a negative effect on humans (usually called a natural disaster);
- An event comprehends the natural hazard pathway and the human "pathway" or elements impacted (assets, receptors or resources exposed). The hazardous event is part of the event pathway. Its effects on assets are also part of the pathway, or event description (Figure 3.8). When describing an event refer both.

Figure 3.8 illustrates the steps involved in risk identification based on events. An event can have a combination of sources and have multiple consequences.

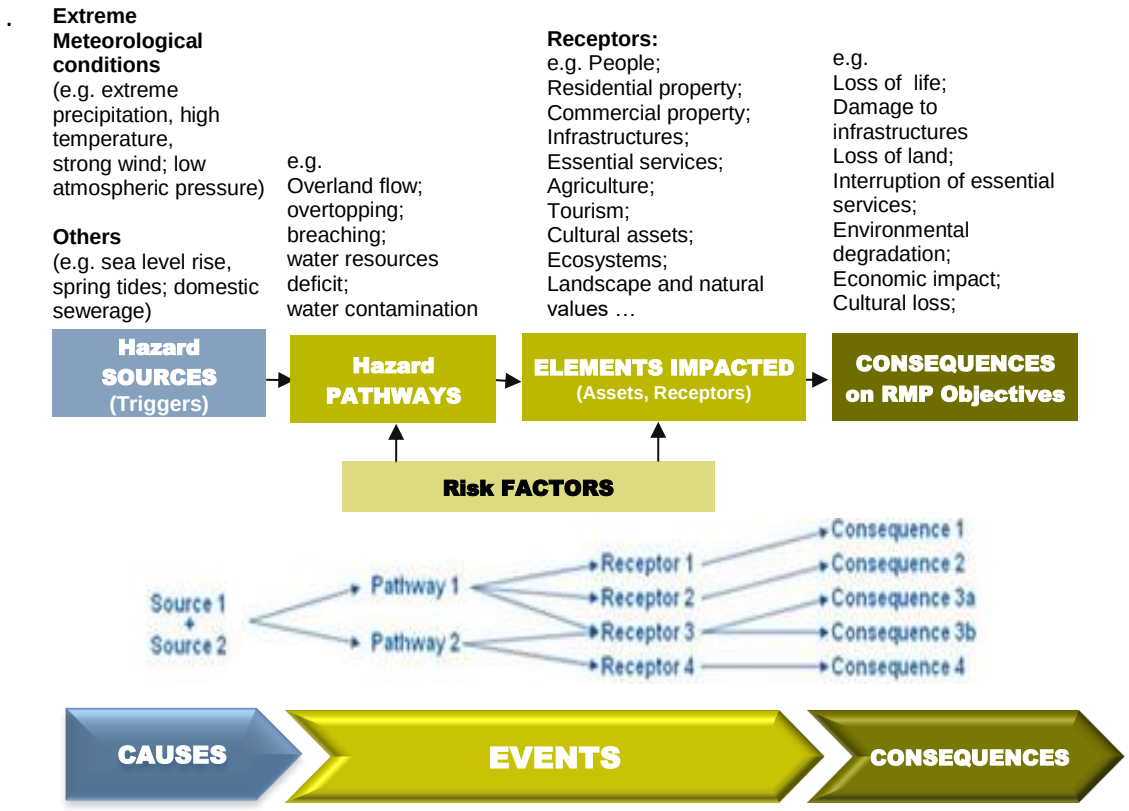


Figure 3.8: Task 2 - Listing events

At BINGO, for each type of hazard (water resources deficit or inundation) events were designed associating one or more hazard source (e.g. storm surge with spring tides; precipitation and temperature), with different likelihoods, using climate change prediction replicas from BING WP2. Pathways (climate → hydrological manifestation) were produced within WP3. Human risk factors were added when performing risk identification in WP4.

Step 4: Risk analysis

Risk analysis is about developing an understanding of the risk. The main output is the level of risk (risk estimation). It provides the basis for risk evaluation and decisions about risk treatment.

Risk analysis consists of determining the consequences and their probabilities for events identified in the previous step (risk identification). The consequences and their probabilities are then combined to determine a level of risk (Figure 3.9).

1. Assess Hazard Likelihood
2. Assess Consequences
3. Estimate Level of risk

Figure 3.9: Main tasks of risk analysis

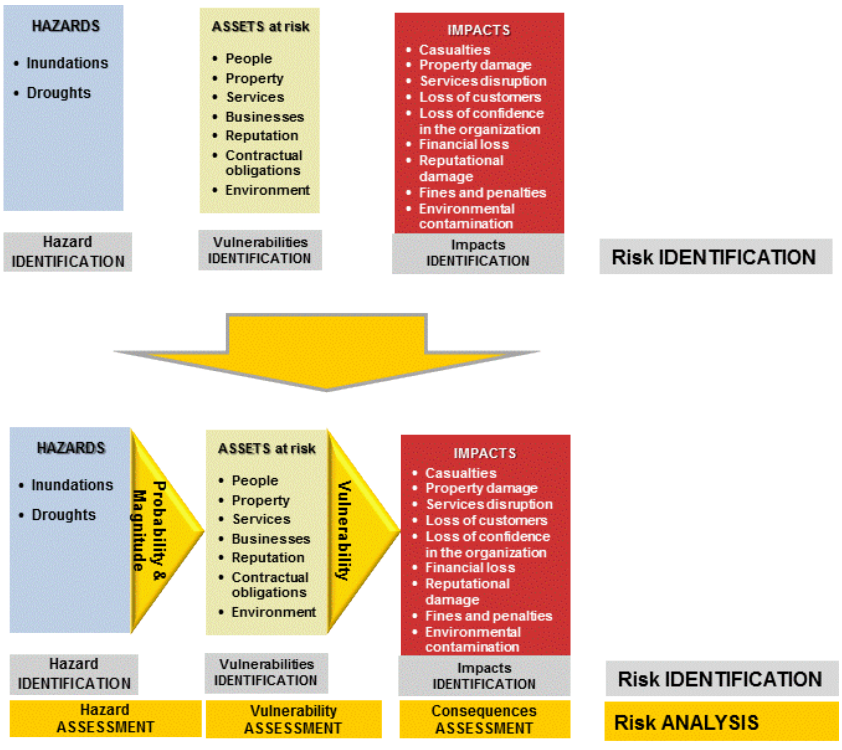


Figure 3.10: From risk identification to risk assessment (Adapted from https://www.ready.gov/risk-assessment)

The jump from risk identification to risk analysis relies on assessment rather than on identification (Figure 3.10). So, the first step of risk analysis is to establish a risk score. For each item two important questions are: a) what is the **likelihood** that this risk will happen, and b) if it does happen, what is the **impact** to my organization's objectives? After scoring both likelihood and consequences, scoring the risk results from combining both.

Risk analysis (scoring the risks) can be undertaken with varying degrees of detail, depending on the risk, the purpose of the analysis (and the decision-making needs of the organization), and the information, data and resources available (ISO, 2009b). Qualitative, semi-quantitative and quantitative methods can be used for hazard assessment, consequences assessment, as well as for the combination of these (level of risk), depending on the circumstances, as referred in ISO 31010:2009 (ISO, 2009c):

Full quantitative analysis may not always be possible or desirable due to insufficient information about the system or activity being analysed, lack of data, etc. or because the effort of quantitative analysis is not warranted or required. In such circumstances, a comparative semi-quantitative or qualitative ranking of risks by specialists, knowledgeable in their respective field, may still be effective.

In BINGO risk analysis was performed based on the events designed in task 2 of risk identification. For the majority of research sites, the method used to estimate the level of risk was qualitative and based on risk diagrams (Figure 3.11:). The main advantage is its simplicity, being easily understandable.

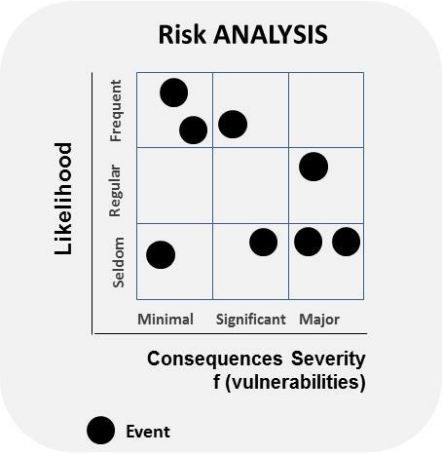


Figure 3.11: Risk analysis output in BINGO

Hazard assessment was not easy to quantify for the majority of situations. Assign a probability to the hazard source (extreme climatic phenomena - precipitation) was possible but it was difficult to the consequent hydrological manifestation (hazard) as no direct association exist due several influencing factors.

Consequence assessment was performed in the majority of cases based on qualitative vulnerability scoring. In BINGO key vulnerabilities were identified considering, for each socio-economic activity addressed, the interaction between "*sector ↔ natural system"* and "*sector ↔ socio-economic system*" (Figure 3.12).

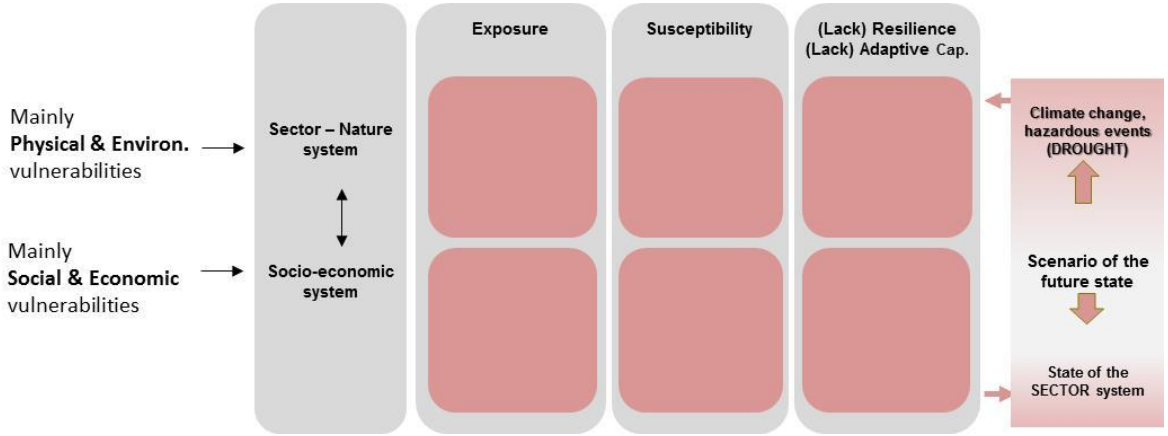


Figure 3.12: Vulnerability assessment

Step 5: Risk evaluation

Risk evaluation is about judgement. It is the process of comparing the results of risk analysis with risk acceptance criteria, established in the context, to determine whether the risk and/or its magnitude is acceptable or tolerable. By grading the risks, risk evaluation assists in the decision about risk treatment. It is important to clearly identify the entity/person or entities/persons responsible for establishing risk criteria, as it will have a large impact in risk management.

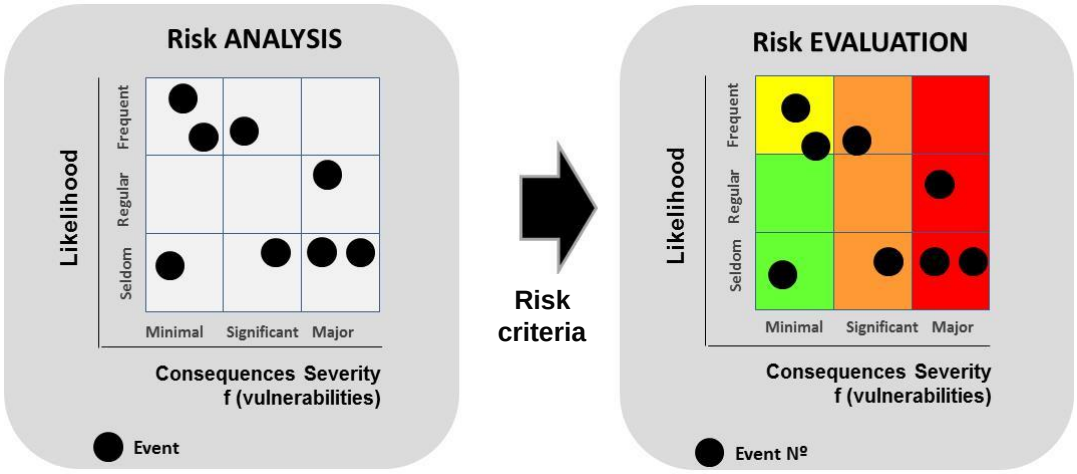


Figure 3.13: Risk assessment

It is immediately evident that the top right quadrant is where the most worrying risks are placed.

In BINGO risk criteria was a difficult process to be established, as no large experience existed among partners. From the six research sites only one stakeholder had a risk culture already implemented and oriented for climate change adaptation. Knowledge transfer helped implantation and homogenization among case studies.

4. CONCLUSION

Implementation of a risk management process fulfils the promised BINGO contributions as it:

1. provides the foundations necessary to assist integrating risk assessment into climate change adaptation by providing means to evaluate and prioritise risks to support decision-making, strategies definition and inter-sectorial conflicts management;
2. assists to establish internal and external reporting and communication mechanisms to facilitate communication among risk managers, stakeholders, technicians, scientists, decision-makers and all other intervenient in the process.

By providing support on structuring relevant information, including the definition of objectives and analysis of the impact of climate changes upon those objectives, RMP improves the knowledge of socio-economic water related key stakeholder´s perception of risk imposed by climate change extreme events, and the need to define strategies and find the resources to overcome the difficulties and accomplish the objectives. It also provides support on defining those strategies. By using designed events, plausible impacts become more realistic and understandable to stakeholders.

Although some of the methodologies are already well-known, it is often new the application of risk management methods to cope with the impacts of climate change.

RMP also assists on the development of metrics to define success or failure of socio-economic water related key stakeholder´s activities and objectives, allowing strategies adjustment along time.

Different realities were reached in the BINGO project. Some exploitable results are characteristic of the specific research site. As an example it is said that in Portugal the need for improvement of the top political/ institutional practices is evident, as it was identified as being the most relevant vulnerability factor. This outcome can't be generalised. The same methodology implemented at each research site lead to different results, as expected, varying with hazard type, risk owner (type of activity and level of approach: policy making, entity level, individual) and specific existing key vulnerabilities.

Decision under uncertainty is not appreciated by people in charge, no matter its ranking position. Policy makers, professionals, stakeholders, all categories of parties would rather know exactly how climate changes would evolve and what their consequences are.

Only one stakeholder had already adopted a risk management framework prior to BINGO (EPAL- Public Water Supply Company, in Portugal). For the majority, a risk management approach was quite new. Introducing a risk approach into an organisation or a society requires some internal changes.

All types of end-users, from top to bottom, need to understand what is at stake when decision under uncertainty needs to be taken. Introducing a risk culture still has a long path to be pursued before being adopted. At sectorial level, were economic impact is directly felt; a risk culture might be more easily adopted, although acknowledgment of their benefits still has to be developed. At top political level, where direct contact with the reality of the risks is often inexistent, a risk culture could be extremely helpful to support decision in adapting and combining several different conflicting or competing sectors for the same resources. To reach such end-users will be the most challenging job.

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