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# Implementing Risk Governance in the European Water Framework Directive

## Case study Märstaån Catchment, Sweden

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## Abstract

The overall aim of this study is to analyze how a risk governance process can be used while working with the EU Water Framework Directive on a local catchment level. A case study has been done on the catchment Märstaån in the eastern part of the lake Mälaren, Sweden. The first part of the study details the existing risk handling structure from the top level of the Water Government organization (Vattenmyndigheten) down to the local actors influencing the water quality of the Märstaån River. The second part is an investigation on how the main local actors work with risk and how this can be related to the work of the Märstaån Water Council doing risk assessment to secure the water quality for the Märstaån River. Main question is if this work can benefit from the use of the IRGC Risk Governance Model. The findings shows that there is a disconnection in the risk handling process between the top and local levels that can be improved by including a local water council in the risk process. The use of an adapted version of the IRGC Risk Governance model can facilitate the work of a local water council and make the work more visible to the general public.


## Content

# 1 Introduction and Scope

The EU Water Framework directive (WFD) has been implemented in the Swedish law legislation to meet the requirements of good water status by 2015. This has affected the organizational structure of Swedish water management as WFD requirements states that management will now be done according to natural boundaries of river basins.

A new Water Government organization has been formed to coordinate the work of preserving and improving water quality for the Swedish part of the Baltic Sea Basin according to the EU Water Directive. New local councils have been formed on a local catchment level to work together with affected local stakeholders according to general guidelines formed by the Swedish Water Government.

Today risk assessments and handling is clearly visible on the Baltic Sea and on a River Basin level where the risk of not meeting the water quality requirements are assessed every sixth year, see Figure 1. On each level there is a cyclic process ongoing that involves risk assessment, risk appraisal, risk evaluation and risk management related activities. On the catchment level there is no risk management activates clearly visible today.

In the sub level below the Catchment area some of the local actors are filing for environmental permits to start, expand or change their operations providing some risk analysis in their environment impact study and in the following maintenance phase.

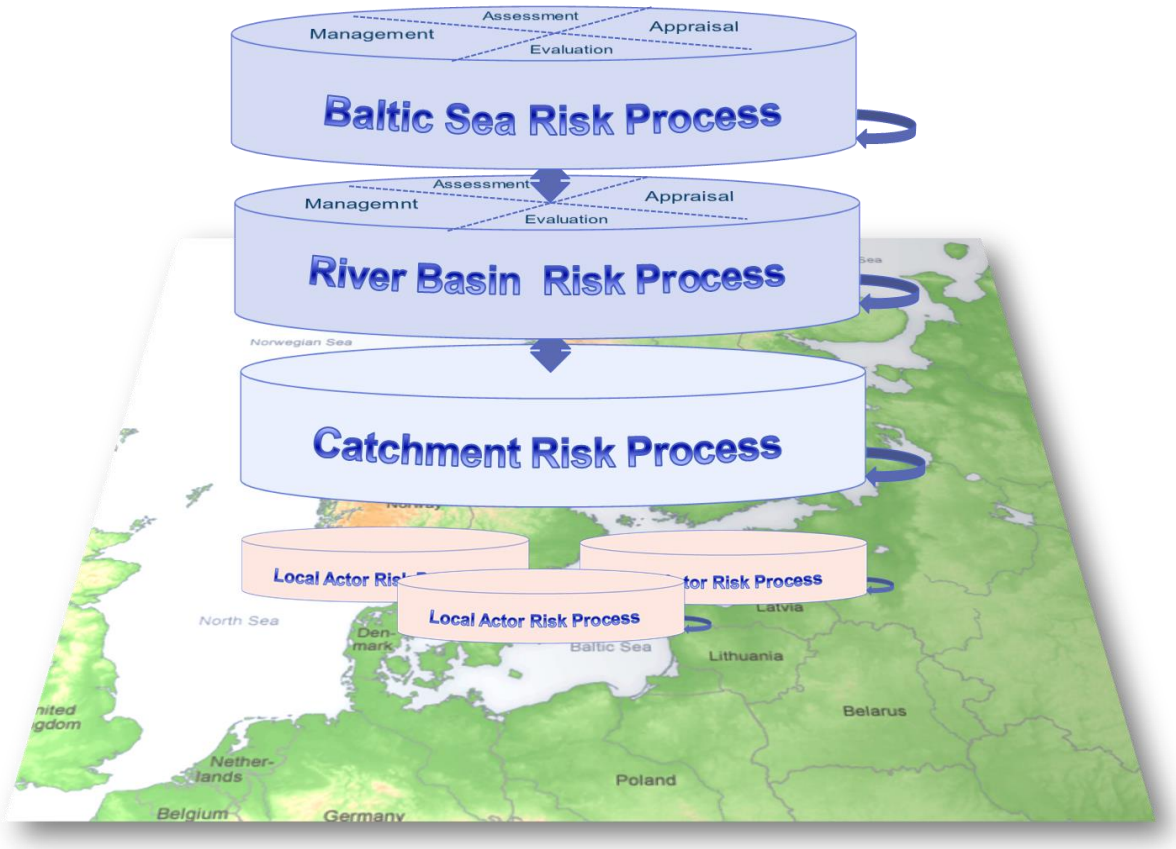


**Figure 1 Water Quality Risk Processes for the Balitc Sea Basin (M Norling)**

As risk management seems to be a minor focus for the local water councils of today a hypothesis is that more focus in this area could be one way of actually make the work of the local council more structured and easy to understand for the members of a local water council and the general public.

To verify this hypothesis an overview of the existing risk handling structure, see Figure 1, is done to form the baseline for the more extensive analyzing work that is done in the case study on a local water council level. The case study is carried out on Märstaån, one of the local catchment areas belonging to the Northern Baltic Sea River Basin District. Here the implications of implementing a risk handling process model, based on the Risk Governance concept by Ortwin Renn, are analyzed (Ortwin 2008).

As the time span for this study was rather short the analysis work is done only by going through available information sources on the net. No specific interviews or other qualitative information retrieval has been done even though I have been in contact with some persons involved on all the levels of the water management structure and asked for information updates.

The following questions will be the focus for the analysis of the work of a local water governance organization.

- *Is there a need of a structured risk assessment on the Catchment level?*
- *What are the benefits for a Water Council of introducing a risk governance model?*

# 2 Background

## 2.1 Risk Assessment Structure

The Swedish Water Government perform and report risk assessment on a Baltic Sea level based on requirements from the European Union and on applicable parts of the Helcom Baltic Sea Action Plan. This will then be the main input to a River Basin district organization that is formed according to the natural boundaries of river basins. The next level is the local catchment Water Council that coordinates activities on a local level based on the requirements from the River basin level. The organizational structure, from a risk analysis point of view, can be interpreted as what we see in Figure 2.

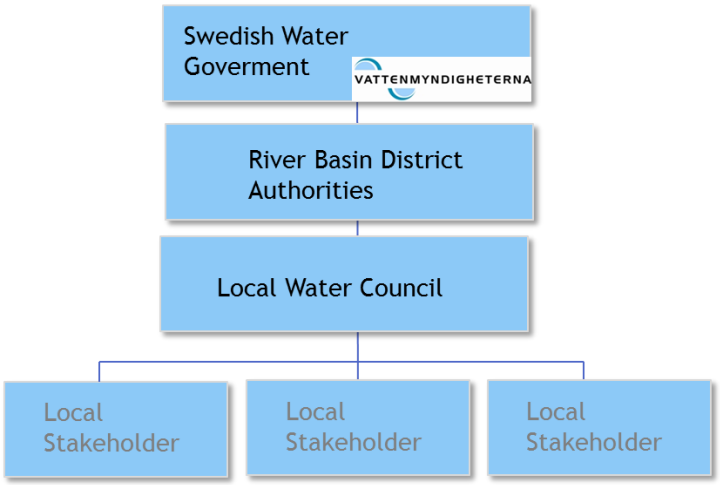


**Figure 2 Organizational structure for risk assess**

On the top level the Swedish Water Government organization work on a six year cycle, setting goals and reporting water status to EU, see Figure 3.

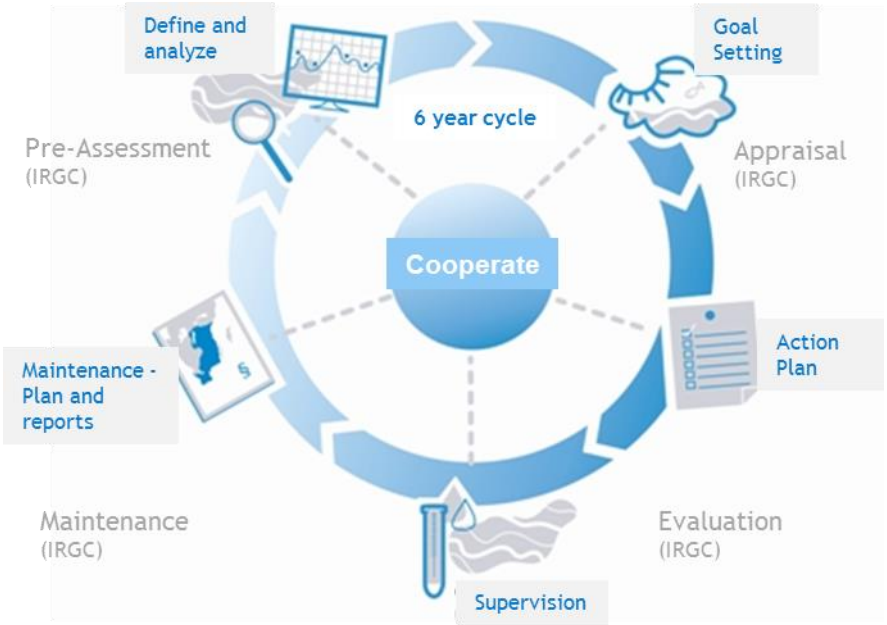


**Figure 3 The six year working cycle of the Swedish Water Government organization (Adapted from "Vattenmyndigheten")**

On the next lower River basin level the included water systems are mapped and the actual status described. The district authorities makes a risk analysis about the probability to not reach good water quality at year 2015 and if needed then makes a plan on how to reach targets with reasonable additional efforts and measures.

The local water council activities related to risk analysis are not clearly stated by the Water Government. There is a general recommendation on activities for water councils from some of the River Basin districts that states the following main activities (Södra Östersjöns och Västerhavets vattendistrikt , 2007).

- Stakeholders meets and discuss common water problems
- Act as an information channel between authorities, stakeholders and the general public
- Take an overall view of the water flow from water source to the sea
- Works according to water basins
- Participates actively in activities on the river basin level
- Discuss and present realistic proposals for action considering cost effective solutions

On a local stakeholder/actor level different ways of risk handling can be identified. Some big companies that are starting new activities or expanding their operations are filing for environmental permits providing extensive impact analysis documentation with clearly visible risk analysis. Smaller companies (Class A/B according to the Swedish law, 1998:899, about environmental dangerous operations) are requested to provide an environmental impact assessment. Already ongoing long term activities, like existing farming, do not have to present any documents stating their impact on water quality even if that is the case.

## 2.2 Case study - Märstaån catchment

The Märstaån catchment is situated just north of Stockholm, Sweden and the area is approximately 80 km2. It belongs to the Northern Baltic Sea River Basin District and drains via the lake Mälaren and Norrström to the Baltic Sea, see Figure 4.


**Figure 4 Catchment Märstaån outlined in red. Argiculture areas are marked in yellow and urban areas in brown. ©Lantmäteriet Gävle 2011 Medgivande I2011/0097 ( Norling 2011)**

37% of the area is industrial areas, airport, roads and hard surfaces. From northeast the Halmsjöbäcken stream connects at the reference point F after running through/under the Arlanda International airport. The actual part named Märstaån starts at ref F and run mostly underground in the" Moralundstunneln"(Norling 2011). The companies Fortum and SÅAB are situated in the Brista valley south of point F.

## 2.3 VISS data

The water quality of the Märstaån river can be accessed in the Swedish data base VISS where detailed information about the current status can be found according to the requirements in I EU:s water directive (2008/105/EG) and assessed by the Northern Baltic Sea River Basin District organization and the Stockholm County Board ,see Figure 5 .

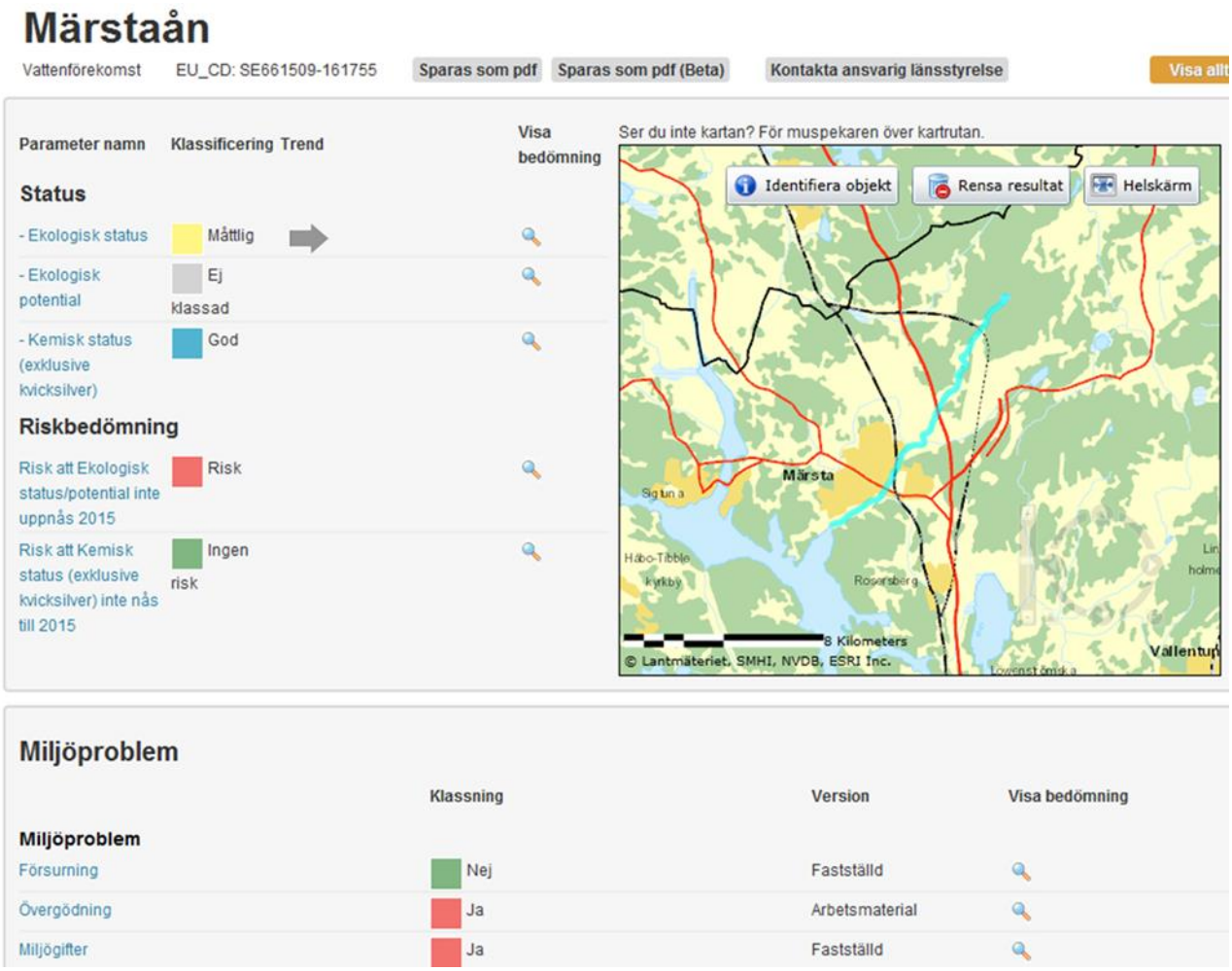


**Figure 5 VISS Status and assessment for the Märstaån catchment 2013-03-07**

The VISS database contains maps of all major lakes and watercourses and for all these waters you can find information regarding status classification and assessment of water quality. The ecological and chemical status is shown together with an assessment of the risk that it will not meet the goals set for year 2015. Today the risk is "red" on the ecological status related to problems from eutrophication and environmental toxins (http://www.viss.lansstyrelsen.se).

## 2.4 Märstaån Water Council

The Märstaån Water Council was formed in January 2011. The council is driven by the County of Sigtuna where the catchment is located. Members are all the major actors in the area and a representative from the Stockholm County Administrative Board that has the responsibility to ensure that the EU Water Framework Directive is implemented correctly (Mälardalsrådet 2011). The Märstaån "Water council vision and goals" document state that the council should be perceived as a good example for other councils in Sweden and that their common water will make them proud and expectant for the future. In their goals they state that knowledge about ecological and chemical quality is important and they are building a common recipient reporting system covering most of the area. More specific they state that the status in all parts shall be regarded as good/green at the latest in the year 2021. Full members of today's water council is the local actors Swedavia, Fortum Heat, Sigtuna County, LRF represented by two local farmers, Stockholm County board and with Ragn-SELLS/SÅAB in the process of joining (Samverkansdokument 2011).

## 2.5 Local major actors

### 2.5.1 Swedavia

Swedavia is running Arlanda International Airport that's situated inside the catchment area. In April 2011 they filed for a new environmental permission to handle the increased traffic situation. This case is still ongoing at the environmental court (Swedavia ansökan 2011).

Storm water is processed in dams at the airport and flows via Kättstabäcken and Halmsjöbäcken to Märstaån. At the reference point "F" the water quality is monitored in real time and the data is used when calculating parameters from an eutrophication point of view, see Figure 15.

Swedavia also has an extensive water quality monitoring system inside the airport at several places and in the lake of Halmsjön, just outside of the airport. One of the environmental problems to monitor, besides eutrophication, is leakage of fluorinated surfactants (PFOS) from the old firefighting exercise grounds (Swedavia Dagvatten 2011).

### 2.5.2 Fortum

Fortum is right now extending its existing facilities for combined heat and power production supporting district heating. Today it's based on biomass incineration but the plan is to also use different kinds of waste for incineration in the new plant. This will affect the water quality in the Märstaån River. Today the existing flue gas condensation excess water is removed from the process and fed to the Käppalaverket waste water treatment facility in Stockholm. Because of a cadmium content in this condensation water this will no longer be permitted by Käppalaverket and the water will be feed to (or just outside) the catchment area instead.(Fortum 2009).

### 2.5.3 Ragn-Sells/SÅAB

SÅAB is applying for a new environmental permit for their extended recycling and deposit operations in the Brista valley. They want to process and store different kinds of waste material that then will be delivered and used by Fortums new waste incineration plant that is situated close by. Drainage water from the old deposit and from some new activities will be fed to the small river Rosersbergsbäcken through a dam system. There are some concerns about flooding of the dam system at heavy rain storms (SÅAB 2012).

### 2.5.4 Agriculture

There are a number of farms in the catchment area and two of the farmers are members of the Märstån Water Council. Their main focus is on the reduction of Nitrogen and Phosphor leakage from farm lands. There is some reduction programs (Greppa Näringen) ongoing and they can also apply for subsides from EU even though that is an administrative challenge (Norling 2011).

# 3 Materials & Methods

The study was done by going through the available documents accessed through internet in order to understand what ongoing activities could be interesting from a risk governance point of view. I also contacted every major actor by mail or telephone and asked for the latest relevant information. No interviews were performed due to the short timeframe for this study.

# 4 Theoretical and Analytical Framework

The theoretical framework consists of

1. Risk Governance model by Ortwin Renn (Ortwin 2008)
2. Operational principles of sustainable development by Mikael Karlsson (Karlsson 2005)
3. Social Media and the Environment by Robert Cox (Cox 2013 p183)

## 4.1 Risk Governance

The concept of risk is about the distinction between a possible and a chosen action. When an organization or a society faces several options to act on where each is related to potential negative or positive consequences a decision is to be made. Sometimes a decision can be reversed but it can never start from the beginning again. Evaluating the risk for the different options helps people to select the alternatives that promises some benefit comparing with the other options (Renn 2008 p.1).

Normally in risk assessment we talk about *Hazards* that has a potential to cause harm and *Risk* as having a probability of a particular negative effect and an extent. The risk evaluation will then be presented in a diagram like what we see Figure 6.

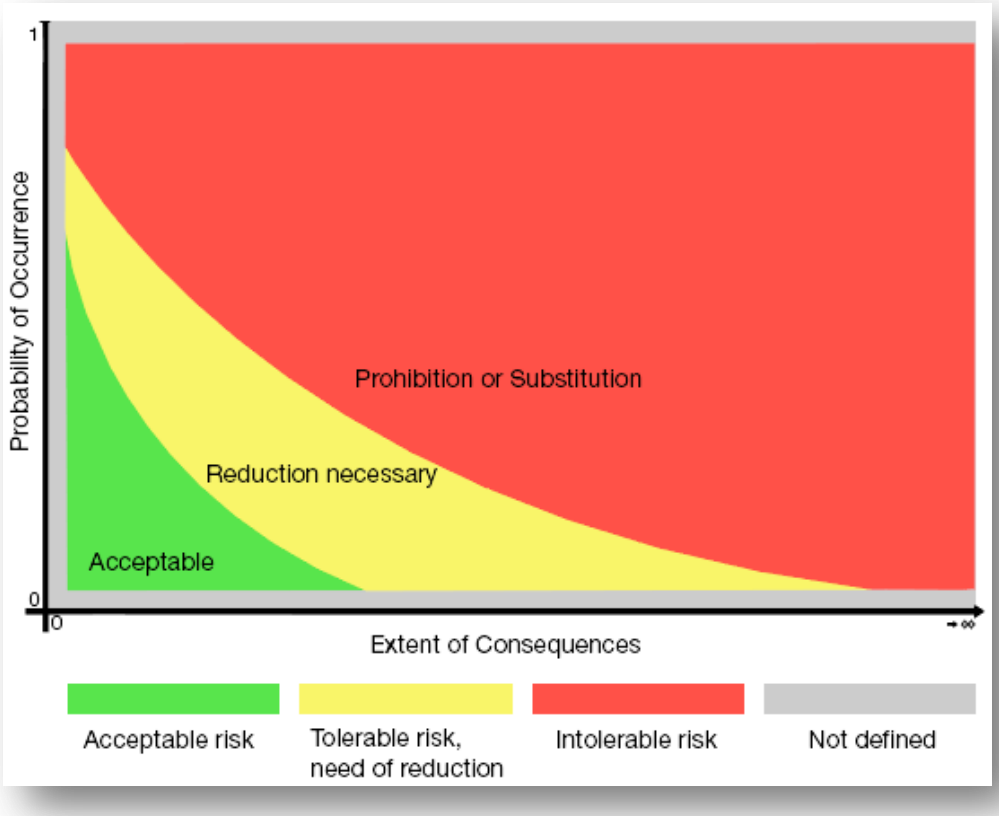


**Figure 6 Acceptable, Tolerable and Intolerable Risks (Traffic Light Model, source IRGC, 2005, p37 )**

The IRGC model, see Figure 7, emphasizes that Risk Governance must look into both the physical and social dimensions of risk and that a multidisciplinary approach is needed (Renn 2008 .p3).

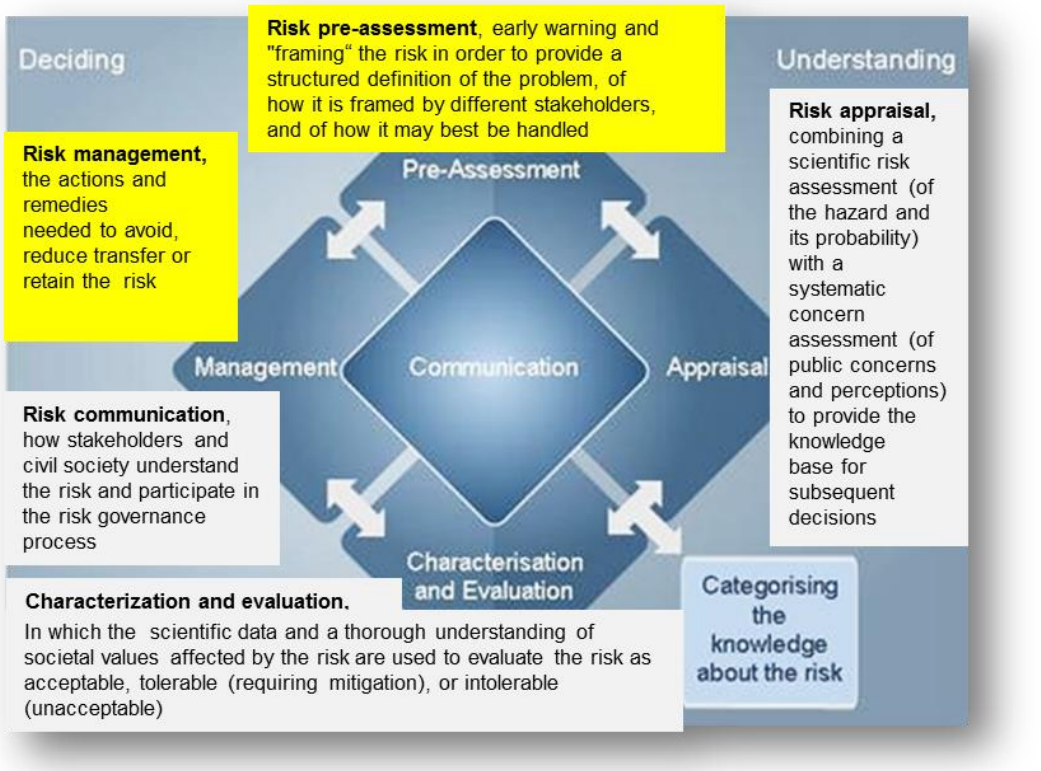


**Figure 7 IRGC risk governance framework**

The model is divided in four different phases that combined together comprises what is called a Governance framework that describes processes and structures for governmental or non-governmental collective decision-making.

In the **Pre-assessment** phase the problem is defined and framed. Here we look into what major actors like governments, the scientific community and what the public opinion selects as a risk. We also look into societal values and what we know about persistence, exposure and suspected impacts of the hazard. Problem framing, early warning, risk screening and scientific conventions are major components in this phase (Renn 2008 p.48).

The **Risk appraisal** phase comprises of two components. The first is to do a more scientific risk assessment of the impact to the environment and to the human health. The second component is related to economic and social implications (Renn 2008 p.67).

In the **Characterization and evaluation** phase we do a judgment about the acceptability and tolerability of a specific risk and present this in a model like we see in Figure 6 (Renn 2008 p.147).

**Risk Management** is about reviewing all the relevant information collected in earlier phases to understand if we have an intolerable, tolerable or acceptable situation and what options are available to handle the situation (Renn 2008 p.171).

**Communication** is needed for all phases in the model and will reflect the specific issue under consideration. This is a two-way communication process between risk managers and other stakeholders including the general public (Renn 2008 p.171).

## 4.2 Operational principles of sustainable development

As the IRGC model extends beyond the phases that normally are used for risk analysis (assessment, management and communication). Considerations of legal, social, institutional and economical aspects are added (Renn 20008 p.8).

One way of assuring and clarifying this multidisciplinary approach is to focus the work according to the "Operational principles of sustainable development", see Figure 8.

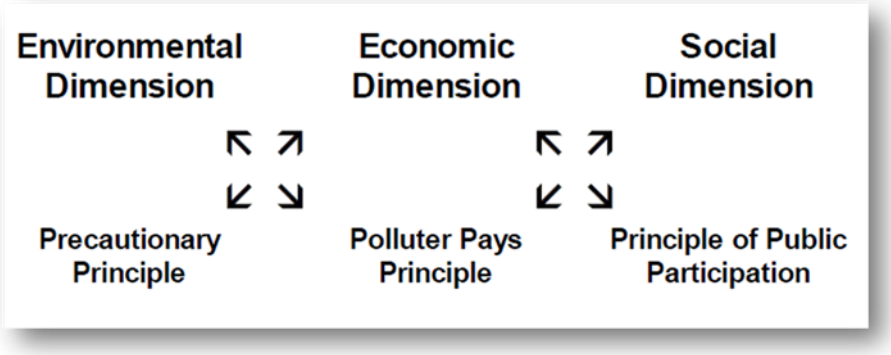


**Figure 8 Operational principles of sustainable development (Karlsson 2005)**

When assessing the different risk factors that can arise in the catchment area it's essential to use the Precautionary Principle in the Environmental dimension. This means a focus on empirical references, science-based suspicion and knowledge and also layman knowledge in environmental monitoring

In the Economic dimension the focus is on the Polluter Pays principle as EU stipulates compensation for environmental damage. This also promotes mitigating measures and socio-economic efficiency.

The Social dimension is covered by the Principle of Public Participation that empowers citizens and enables decision-makers to understand more.

## 4.3 Social Media and the Environment

As communication of today is closely related to social media and the introduction of the new Web 2.0 applications I will use the more modern theoretical approach by Robert Cox instead of the communication part in the IRGC model.

This is a shift from one way communication to a model that comprises content generation and sharing see Figure 9.


**Figure 9 The Social media landscape of 2013 (M Norling)**

Today millions of people are engaged in the network public sphere to find, rank, tag, create, distribute, mock and recommend content in the environmental dimension. Some of the major functions of social media to communicate on the environment are (Cox 2013 p177);

- Environmental information finding
- Green communities and social networking
- Reporting and documenting of environmental status
- Public criticism and accountability
- Mobilizing supporters and the general public

# 5 Results & Analysis

With help of the theoretical framework an analysis of the existing multi-level risk structure, see Figure 1, is done from the top layer down to the local actors about the possibility to relate the Water Councils activities to requirements from the top levels and to the IRGC Risk model, see Figure 7.

## 5.1 Multilevel Risk Structure

### 5.1.1 Top Level Risk Activities

On the top level The Swedish Water Government works in a six year cycle where the different phases are repeated every cycle, see Figure 3. For every water system the present water quality is assessed and environmental quality requirements are defined. Even if the input to a lower level through the VISS database is expressed as a risk, the risk assess methodology is not that visible in the process descriptions. Looking into what is done related to risk in each phase the following mapping to the IRGC model seems to be proper.

The “define and analyze” phase corresponds to the IRGC pre-assessment phase, “goal setting” to the IRGC appraisal phase, “action plan and supervision” to the evaluating phase and “maintenance plan” to the maintenance phase, see Figure 3.

### 5.2.1 Local Actor Swedavia Risk Activities

The major activity in the catchment area of today is the new environmental permit for Stockholm-Arlanda International Airport. In February 2012 Swedavia delivered a requested update of the original MKB from April 2011. In the MKB application there are several parts with information on the water effects on the Märstaån at their reference point “F”, see Figure 4.

The main contribution to the Märstaån water quality is N, P and organic material originating from runway deicing in winter time. There is an extensive monitoring program ongoing and a regular report about the level of nutrients that flows into the Märstaån. Several treatment dams are already built and one new for Runway 3 is under construction. All this in order to meet the existing requirements of good water staus (Norling 2011). They also state in the MKB application document that being part of the Märstaån Water Council and contributing to more dam construction downstream of “F” is part of their plan on how to work with water quality (Swedavia ansökan 2011).

In the MKB part there is a document with 158 pages that details the impact on the water system. Here is information on proposed requirements levels for different substances. One of the areas highlighted as a concern in the MKB is the level of fluorinated surfactants, PFOS, originating from earlier firefighting exercises involving fire suppressing foams. The contaminated area is now treated and the effects on the lake Halmsjön and the small river Kättstabäcken are investigated in an extensive research project driven by IVL (IVL Svenska Miljöinstitutet 2012) and planned to be ready in year 2014 (Swedavia - MKB kap 7, 2011).

In an appendix to the MKB, Chemical Risks, they are presenting the principle for Swedavias Risk assessment. It’s focused on the handling of chemical substances and the risk for environment, health and the risk for fire. They use what they called a semi quantitative perspective and define the risk as

Risk = Probability * Severity

They clearly state that there are problems involved in the assessment and that the semi-quantitative scales are not linear and the grading mostly a guess (“mellan tummen och pekfingret”). For the environment assessment the severity scale is divided in 4 classes with a corresponding value.

1 point – Short term damage on a small lake
2 points – Long term damage on a small lake or short term on a medium lake
3 points – Long term damage on medium lake or short term on big lake
4 points – Long term damage on big lake (> 1 $km^2$ )

For the probability the scale is

1 point – Once every 100 year
2 points – Once every 10 year and once every 100 year
3 points - Once every year and once every 10 year
4 points – More than once a year

As the Probability and Severity is logarithmic (each step is 10 times higher) the formula used for the risk matrix calculation, see **Figure 10**.

log R = log S + log A

| log Allvarlighet / log Sannolikhet | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 4 | 5 | 6 | 7 | 8 |
| 3 | 4 | 5 | 6 | 7 |
| 2 | 3 | 4 | 5 | 6 |
| 1 | 2 | 3 | 4 | 5 |

**Figure 10 Swedavia Risk matrix**

If the calculated sum are equal or less than three no action is needed. Otherwise there is a proposal of action.

As an example there is a chapter on the risk of contamination from fire foam (PFOS-related) that deals with different scenarios where the calculated risks are between 1 to 6 and four different proposals of actions for the rescue operations are detailed (Swedavia  Kemiska risker 2011).

### 5.2.2 Local Actor Fortum Risk Activities

The plan outlined in the environment impact study (Fortum 2009) is to feed condensate water, from the new and old incarcerator, to a water treatment dam and then into the Märstaån river or the lake Mälaren. The construction of this dam is ongoing right now, see **Figure 11**, but there is also a public opposition stating that this will affect the local fishing in the nearby Steningeviken, see Figure 4. This has also been addressed by the environmental court in the pending environmental permit process that states that no condensation excess water can be fed to the Märstaån river when the Märstaån river flow is below a certain volume (Nacka Tingsrätt 2010). This is likely to happen in winter time when Fortum needs the full capacity of the heating plants.

**Figure 11 Fortum Dam Construction 2013-03-10, chimneys visible in the background (M Norling)**

In their MKB Fortum states that the impact on the Märstaån River is small but an incline in mercury, total nitrogen and ammonium is likely. The risk scenario for people living close is estimated as acceptable. The risk assessment process is detailed in a separate MKB appendix that is not available at Fortums home page or on request. In the MKB document there is an overview of the risk process used to calculate the impact from the following objects:

Ammoniac ($NH_3$), sodium(NaOH) , fuel-oil(Ol), LPG(G), diesel generators(Dg), carbon monoxide(CO), storing of waste, biofuel(LB) and transport of dangerous goods(Tr).

A risk scenario is used to calculate the probability and extent of an impact and the result is presented in an risk matrix, see Figure 12 .

| Riskmatris | | Konsekvens | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| Sannolikhet | 5 | | | | | |
| | 4 | | | | | |
| | 3 | LB | | | | |
| | 2 | $NH_3$, Ol, NaOH, Dg | | | | |
| | 1 | G, Gf | Tr | CO | | |

**Figure 12 Risk matrix. Red - unacceptable, Blue – to be investigated, Green - acceptable**

### 5.2.3 Local Actor RAGN-SELLS/SÅAB Risk Activities

In the MKB document there is a risk analysis focused on the environmental impact for alternative locations of the new operations outside of the river Märstaån drainage basin.

One of the main risks is listed as flooding of dams. In the consultation document that particular risk was listed as number two in the main risk list even though no ranking was clearly visible. After the main risk list a statement said that the company was working systematical y with risk handling according to law requirements but no details was given (SÅAB 2012). In the MKB document flooding was at the bottom of the unnumbered list and the statement about risk handling gone (SÅAB MKB 2012).

## 5.2 Water Council Risk Process

The IRGC Risk model, Figure 7, the operational principles of sustainable development, Figure 8 and the social media landscape, Figure 9, will now be used as a framework to analyze the ongoing work in the case study Märstaån Water council. The main information source has been the existing minutes of meetings.

The main analyzing questions to be answered is if how the activities that are described in the available documents can be mapped onto the theoretical framework models and what activities that is missing from a Risk Governance / sustainable development/ social media landscape perspective. The focus will be on the pre-assessment and risk management phases.

In order to map the activities to the IRGC model a simplified and adapted model is used, see Figure 13.

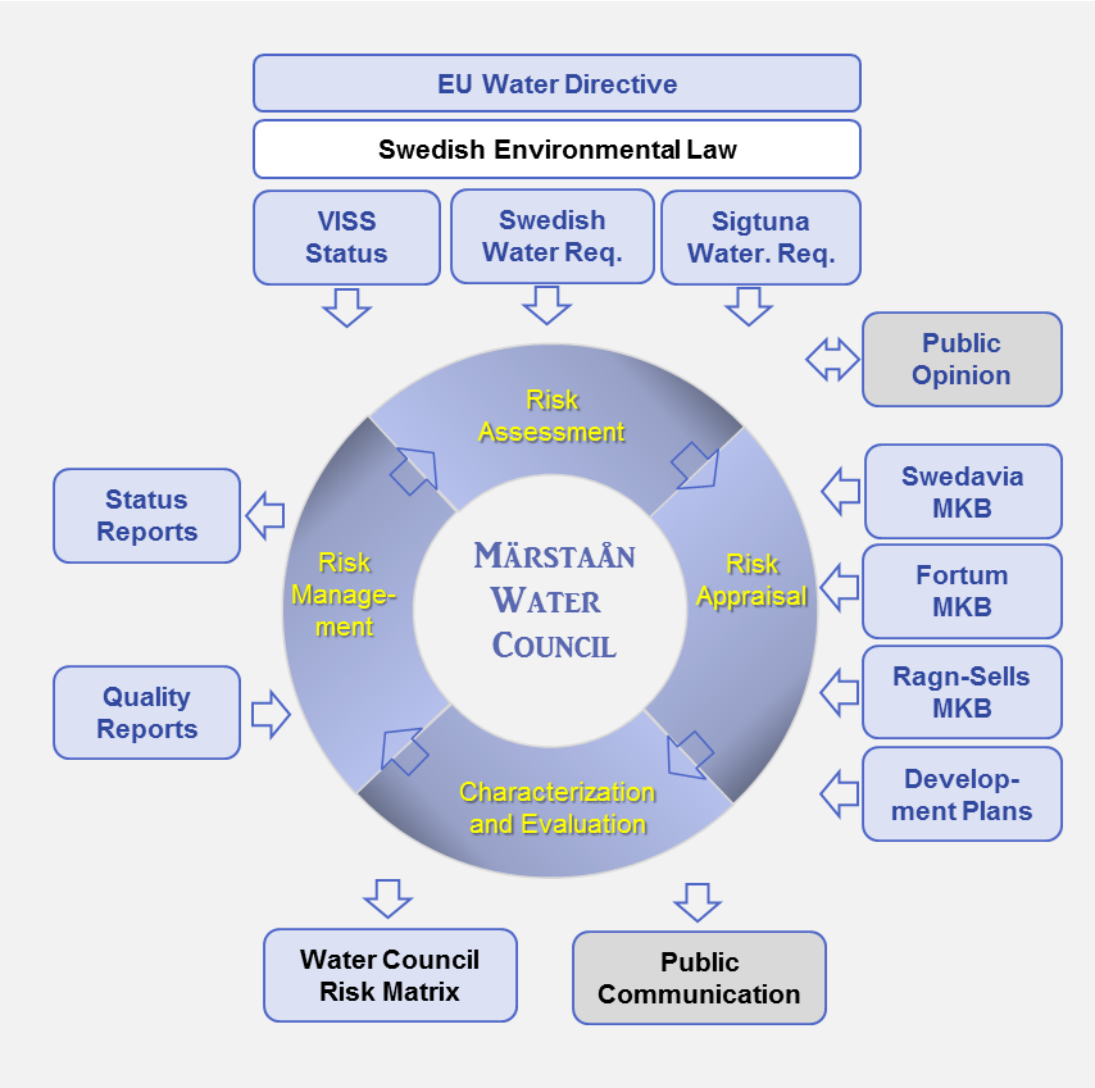


**Figure 13 Adapted and simplified IRGC Risk Governance model (M Norling)**

The model is supposed to rotate clockwise approximately each year or whenever a major development is planned for the catchment area or some new risk is identified. In reality the process flow will change direction and jump between phases adapting to the specific situation. In this study I will use the waterfall-like model to facilitate the analysis and to make it easier for the reader to follow the discussion.

Every activity is not stated clearly in the available documents and some assumptions have been done in order to map activities on the simplified IRGC model. Communication and information flows are represented as arrows in the model.

### 5.2.1 Risk Assessment

In this phase the current status of all of all the input requirements are assessed, see Figure 14.

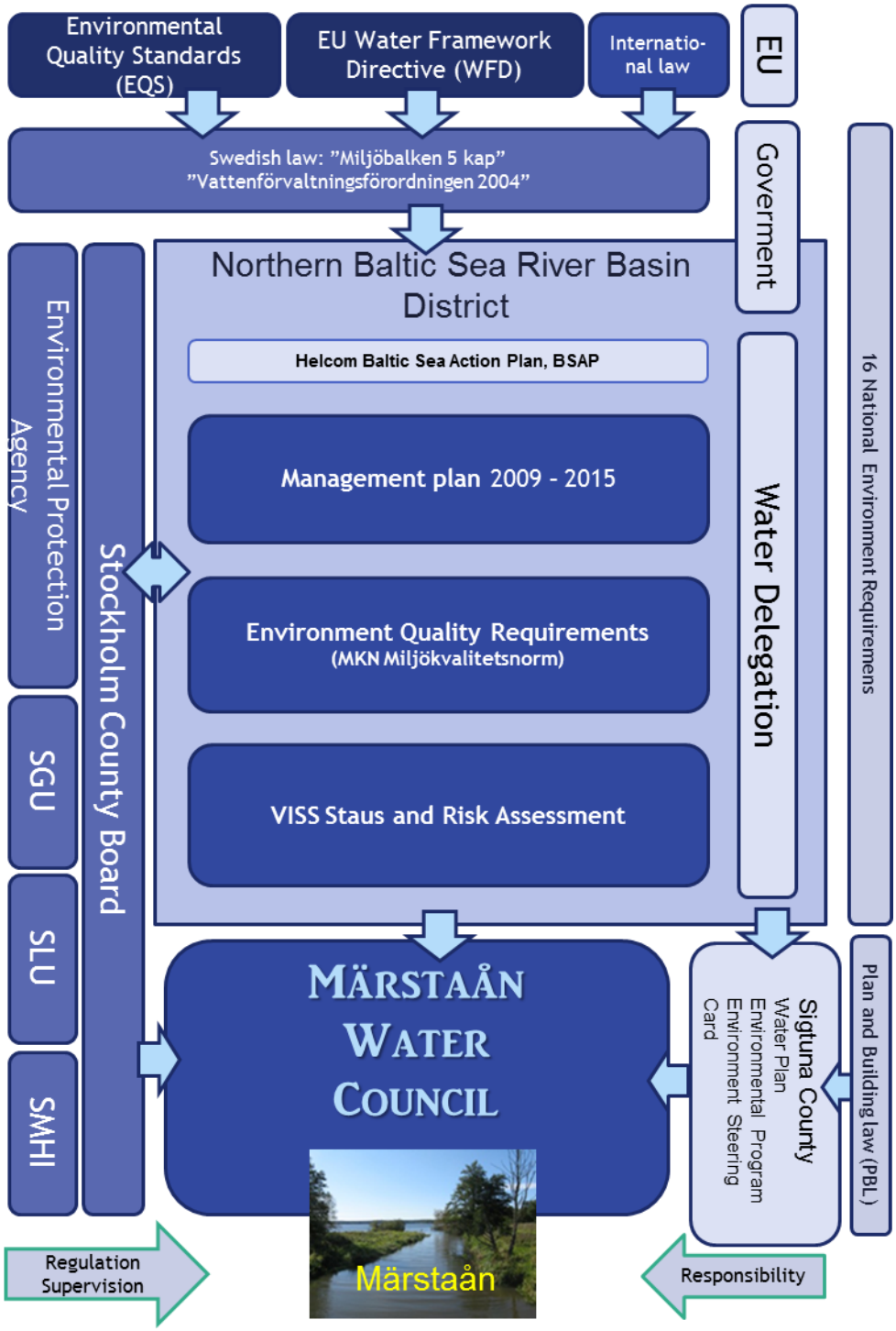


**Figure 14 Main Requirement structure (M Norling)**

The Water Framework Directive (WFD) states that the goal is good water status by 2015 in surface and groundwater managed by the natural boundaries of river basins in an ecosystem approach. The

WFD has been implemented in Swedish law (Miljöbalken, MB) and a new organization has been formed, mapped on the river basins, to supervise the needed activities to reach the goal. More detailed requirements comes from the Northern Baltic Sea River Basin District and their risk assessment of the possibility to reach the WFD goals can be find in the VISS database. The Märstaån Water Council will also have to look into what regional and local requirements that exists from Stockholm and Sigtuna Counties and have a good insight in the regulations from the supervising organizations.

With all that knowledge in place the Water Council has to work with the main question:

*What is the probability that the catchment Märstaån cannot meet the existing ecological and chemical requirements and what are the consequences?*

The status baseline, the water quality of today, will mostly come from the Risk Management phase and the common recipient program.

### 5.2.1 Risk Appraisal

In this phase the Water Council is supposed, according of the model, to do a more detailed scientific risk assessment based on available data and plans and at the same time asses the economic and social implications. The major part of work in this phase could be to analyze the new and pending Environmental Impact Studies (MKB) that affect the Märstaån catchment. In these MKB: s there can be some risk assessments presented focusing on the particular project which can then be used in the risk evaluation phase on an overall catchment level. The consultation phase documentation (MB chapter 6) will also provide valuable information in the social dimension on public participation. The economical dimension is covered in the rules of consideration part (MB chapter 2). Major components in this phase are hazard identification and estimation, exposure assessment and risk estimation

Relevant questions in a Märstaån Water Council perspective can be;

1. Is the risk assessment described in the MKB: s sufficient as to cover the ecological and chemical status of the recipient?
2. Are the concerns of the public, expressed in the consultation phase, covered (social dimension)?
3. Are there some other activities that can affect the ecological and chemical status of the Märstaån River?

This is also the phase where new, previous unknown, hazards will be assessed. An example could be the detection of invasive species like what happened in the Märstaån River late last year. A local person found some examples of the marbled crayfish. They are parthenogenesis crayfish, just females, that were discovered in the pet trade 20 years ago. They have rised concern as only a single individual is needed to establish a population. In a situation like this the complete governance cycle has to be run in order to handle the situation.

## 5.3 Characterization and Evaluation

In this phase the activities will be on a catchments level and driven by the Märstaån Water Council. A risk matrix is made for prioritized hazards/risks and the findings will be used as an input to the risk Management phase.

Risk characterization involves collecting of relevant evidence for determine hazard levels for tolerability and acceptability and options for handling risks. Risk evaluation is about applying societal values and norms and to determine the need for risk reduction (Renn 2008 p155).

As is stated in the theoretical framework of sustainable development, see Figure 8, public participation is important in the social dimension. The current status of public opinion needs to be addressed. One example could be the marbled crayfish. There has been some heated debate in this matter. Södertörns Universitys Research Retriever came up with five hits in major Swedish newspapers about this event where the Swedish Agency for Marine and Water Management (SwAM) is requesting immediate actions (Svenska Dagbladet 2012-12-19 Sida: 18). The Brista+condensate water outlet data base search got eight hits mostly in local papers. A search for Arlanda+PFOS got 27 hits in both local and major Swedish newspapers.

In the Economic dimension of the theoretical framework of sustainable development it states that the "Polluter Pays Principle" is an important indicator to observe, see Figure 8. One example from the Märstaån catchment could be that Fortum has contributed to the cleanup of the nearby Rosersbergsbäcken.

In this phase relevant questions in a Märstaån Water Council perspective can be;

1. Is the risk assessment done in the MKB:s sufficient as to cover the catchment area?
2. Is there some interaction between the different activities that could make the situation worse, or better, for the Märstaån River?
3. Are the proposed actions in the MKB:s sufficient or must some additional measures be done in the catchment area (PFOS, Cadmium etc)
4. What monitoring needs to be done in the Risk Management phase?
5. What is the current status of public opinion?

## 5.4 Risk Management

In this phase the Märstaån Water council oversees the implementation of planned actions in the catchment area and monitors the effects on the ecological and chemical status by recipient measurements.

In this phase relevant questions in a Water Council perspective can be;

1. Are the risks grades as "acceptable" monitored in efficient way?
2. Are the risk reduction measures working for risks graded as" tolerable but with need of reduction"?
3. Are there plans on how to handle "intolerable risks"?

One example from the case study is Swedavias advanced monitoring station at reference point “F”, see Figure 15 .


**Figure 15 Swedavia measurements in reference point "F" (Norling 2011)**

This is part of the continuous chemical monitoring covering Arlanda International Airport and some agricultural land. This monitoring is complemented with sample monitoring from other parts of the catchment.

The ecological status is monitored by diatom analysis initiated by the Northern Baltic Sea River Basin District. An IPS or TDI index is used to show the influence of high nutrients and organic material. By studying of the percentage of shell deformation as an indication of environment contamination, information on heavy metals and pesticides can be found. Number of species gives information on biodiversity (Länstyrelsen Södermanland 2013).

Another important activity is field assessments of the different parts of the catchment area, see Figure 16.

**Figure 16 The Märstaån Water Council on field duty (Photo from Sigtuna County)**

## 5.5 Communication

As is stated in the theoretical framework of the Social media landscape of 2013, see Figure 8, information availability and flows is a major part in the environmental dimension of today.

In this phase relevant questions in a Water Council perspective can be;

1. Is the information about the Water Council work easy available to the general public?
2. Is up to date information available for the risks with great concerns?
3. Is there a need for a special communication package for a certain risk?

The situation of today in the case study is that information within the Märstaån water Council is distributed through email. No official homepage with relevant information exists or any other social media usage.

# 6 Comparison with other environmental risk cases

The IRGC Risk Governance Model can be used for many different purposes in handling environmental risk and hazards.

Anna Berkmann has used the model in her paper, Fracking Fight, analyzing the environmental risks of gas fracking in Germany. Her finding shows that using the model she identified that most regulations invoked was focused on the existing extraction of tight gas that not consider the additional risk with "Hydraulic Fracturing" and "Horizontal Hydrofracturing".

Florin Alexandru Danila used the model in his work "Environmental risks regarding gold mining in Europe. Case study: Rosia Montana Project. The findings indicated that that the local public and NGO: s was not included in the work with the environmental impact study. He also discovered that some of the involved parties used the IRGC model themselves. Metridou Asimna-Soumela did the same findings in her work "The new debate about the open-pit gold mining project in Halkidiki, Greece.

The comparison shows that the IRGC Risk Governance model has two major applications. One is to analyze the risk handling process in ongoing environmental risky operations. The other application is

to use the model as a guideline for organizations responsible of securing the environmental status for a certain area.

# 7 Conclusions and recommendations

## 7.1 Overview of the existing risk handling structure

The six year working cycle of the Water Government organization ”Vattenmyndigheten” and the working process flow that exists on a River Basin level contain activities that are easy to relate to the different phases in the RGGC Risk Government model, see Figure 3.

The visible risk handling on the lowest local actor level in the case study is restricted to what can be found in the existing environmental impact documents (MKB). Swedavia has the best information in the water risk handling area as can be expected from the extent of their operations. Fortum has a visible water risk assessment in their MKB document but that is missing in the MKB from SÅAB. The local investigated actors all refer to the main water requirements for the Märstaån River based on the EU water directive and the risk assessment visible in the VISS archive.

There is a clear disconnect between the risk assessment activities performed on the local actor level and the top level activities. From the River basin authorities the risk assessment is done on the overall catchment area. The investigated actors on the lowest level are mostly assessing the risk on a small part of the catchment area in their existing documents. For all of the other actors in the Märstaån catchment area there is no visible water risk handling information even though they contribute as much as the investigated companies.

There is today no formal body that is doing a bottom up risk calculation based on the different calculations and other information from the local actor level and focusing on the risk at the catchment area as such.

*The conclusion is that there is a need for risk assessment on catchment level and this should be the responsibility of the local Water Council.*

## 7.2 Case Study Märstaån Water Council

The present activities of the Märstaån Water Council cover the essential parts of the Risk governance model even if the different phases are not that visible

In the **Risk assessment** phase that identifies and defines the input requirement baseline, all of the area seems to be covered by the activities of the Water Council.

**Risk appraisal** is not as visible in the minutes of meetings so a fair judgment cannot be done. The actual handling and comments on the MKB: s content is not an activity that involves the Water Council as such. The systematic analysis of risk calculations and public opinion are not a big focus of today’s work in the Water Council.

In the **Characterization and evaluation** phase that judge the acceptability and tolerability of a specific risk, discussion is ongoing but no specific risk matrix is visible. No structured activity seems to focus on the public opinion.

**Risk Management** is about reviewing and interpreting all the relevant environmental information. This seems to be the main focus of the Märstaån Water Council of today. Recipient data collection is coordinated and reports are presented and circulated within the council members. Field studies have been done on a regular basis.

**Communication** within the council is good with regular meetings at different locations with written minutes of meeting. Communication out from the Water council is more or less nonexistent and only at request. No web based application is used for distribution of information on water quality or council activities.

***General recommendation for a water council***

As a general recommendation, based on the findings in the case study, Risk Governance seems to be an usable and efficient process framework to support activities on a local level related to the European Water Framework Directive. A simplified framework could be needed as water Councils are supposed to involve even laymen.

The social and economic dimensions have to be clearly visible in the ongoing work. Communications must also cover the general public. Reports and relevant environmental documentation like MKB: s must be easy available from a common source.

The status of the water catchment can be handed and visualized with help of a adapted Risk Matrix as exemplified in Figure 17.

| *Risk Status Overview fot the Märstaån River Catchment 2013-03-22* | | | | | | | |
|---|---|---|---|---|---|---|---|
| Overall Risk Summary | Ecolocical Risk Summary | Chemical Risk Summary | Risk Appraisal | Risk Evaluation | Risk Managemnt | Water Council Driver | Remark |
| Water Hazard #1 | Accepptable | Tolerable, below requirement | Intolerable (Public opinion) | Separate project | Separate project | Namn | Managed by Local Actor |
| Water Hazard #2 | Intolerable, intrusive speices | | Tolerable | Field Investigation | | Namn | |
| Water Hazard #3 | Accepptable | Accepptable | Accepptable | Accepptable | Data missing | Namn | |
| : | | | | | | | |
| Water Hazard #10 | Accepptable | Accepptable | Accepptable | Accepptable | Data missing | Namn | |

**Figure 17 Märstaån Risk Matrix**

Risks are evaluated by the members of the water council, see Figure 6, and a priority list (top 10) is agreed upon. For every risk a grading can be done according to what the member feel about the status of the Risk Governance for different phases.

A driver should be appointed for every risk on the list to report the specific risk event at the Water Councils meetings. This matrix could then be the main output in the evaluation phase and part of the documentation in Management phase.

As an example we can look at the work flow for the Water Council discovering intrusive spices. The Government process needs to jumpstart with a Risk assessment looking into the risk that this specific specimen can have a negative impact on the Märstaån river biodiversity. After that an assessment of the potential danger and public opinion will be done in the Risk appraisal phase. If the incident is to

be included on the top 10 list then the corresponding phases are color marked according to opinions of the members of the Water Council. A communication package is prepared and published. A responsible person is named and will then correlate the work in the management phase where the risk is to be handled.

Another way to present the risk scenario on an overall catchment level could be in using the IRGC Traffic light model, see Figure 18.

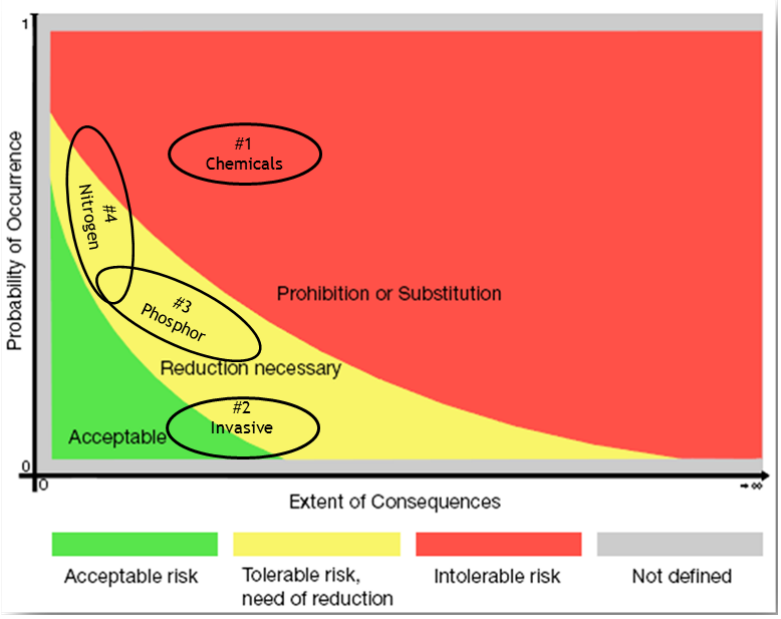


**Figure 18 Overall Risk scenario**

This model gives a good indication on the current risk situation for the local catchment. The specific risks on the top 10 list are analyzed according to the probability of occurrence and the extent of consequences. This information will then be used when grading the risk as acceptable, tolerable or intolerable considering the different countermeasures that can be introduced.

*The overall conclusion is that an adaption of a Risk Governance model would give a needed process structure that will streamline and facilitate the work of the Märstaån Water Council.*

**Vision**
The authors vision for the Märstaån water system (or any other catchment) is to find the latest complete information easy available on the well-structured webpage of the Water Council and updates distributed by Facebook. The online water status parameters should visible through smartphone apps and some nice coverage of the beautiful water landscape to be found on YouTube. Twitter is the communication media used by its members.

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