

Ronald Haselsteiner: Thank you Emir. Good afternoon. First of all, I have to point out two advantages for you that I am not a native speaker. First of all, I will speak so slowly that you can follow me and the second is that I will only use words that you know. Maybe you will understand it, but okay. I stand here as a representative of our responsible ministry of the State Department of Water Resources and last but not least for our Institute of Hydraulic and Water Resources Engineering of the University of Technology in Munich and I hope I can give you and grant you an insight how we care or how we don't care for our protection dykes in Bavaria, Germany. First of all, I want to give you an outline of my presentation after a little bit longer introduction where I want to tell you about two programs that are let's say the arms to the flood threat, or the arms of the local authorities to the flood threat in Bavaria. I want to go on to the experiences, particularly during floods with woody vegetation on dykes.

Then, I will tell you about our technical standards and we Germans, we've got a lot of technical standards, so we even do not know how to build something that is differing from the standards. And, before I end with a few research topics, I want to give you some structural solutions, how we can ensuring with the ability of a dyke even allowing some trees on dykes. So, as my fore-speaker, my Dutch colleague gave you an overview of Dutch, of Holland, you see here Germany -- on the west side you see Holland, on the right side you see Poland, and France on the west side borders Austria and you see the major three river systems -- the Rhine on the west of Germany, the Danube on the south of Germany and the Elbe in the east of Germany. Yes, okay, the Rhine, the Danube and the Elbe. Each of these river systems suffered from floods in the recent years, as maybe you know. 2002 there was a very devastating flood incident at the Elbe region, Elbe River, as you see here. Maybe some of you were on vacation in Germany. You see the [unintelligible] in Dresden that was flooded and on the right side you see the winter flood at the Rhine, in [unintelligible], maybe some of you know.

Then, here you see a famous picture that's been around the world -- this is [Regenstein], a little town with a monastery located in the center of the [unintelligible] and this is the River [Mulde] that's making a bend through the village there. And, maybe you do not remember this picture, maybe you remember this picture where there's four humpty dumpty's on the wall. They are quite relaxed and I do not know whether I will be [unintelligible] but you can relax now. They were safe by helicopter and the wall then broke down. Okay, then in Bavaria, we suffered from several floods in 1999, 2002 and 2005. You will see the monastery of Edinburgh flooded at the Danube and at the other side, you will see a village in the [unintelligible] area flooded. The monastery got a mobile protection measures or devices shortly after the flooding. The village was flooded twice, two times after in 2002 and 2005 and then they got their flood protection devices. So, about damages -- what would that cost after the flood incidents? The Rhine in 1993, and the Rhine 1995 they were quite huge floods, but why should I talk around? The Elbe was outstanding. The damages about 9 billion euros you can flood protect all Germany. So, the answer of the Bavarian authorities -- one program called the Flood Protection Action Program 2020 -- 2020 because in 2020 it will be finished.

Something about Bavaria -- you see Bavaria -- this is located in south of Germany, Austria in the south, the Czech Republic in the East and the Danube is reaching from west to east. Maybe you know Munich, Oktoberfest -- [unintelligible], then you know where you are. We have got 12 million inhabitants and average precipitation about 600 to 2000 millimeters per year and we've got dykes in our larger rivers, at our larger rivers of about 1,200 kilometers. In our minor rivers, there are additionally about 400 kilometers. This program is divided up in three sectors -- natural retention, technical measures provision, and as it was passed in 2001, we will have expenses about 2.3 billion euros until 2020. That means about an average of 120 million a year and after the flood incident in 2005, it was up to 150 million a year. What do we have to do

with this money? I think everything about flood management distance, the [renaturation] of rivers is a big topic in Germany this time. Relocation of dykes of course or flood retention with detachment area. Then we do a lot of controlled [unintelligible] and of course we ought to refurbish our dykes and provision -- we try to improve our forecast of our system, for example.

There are 115 million euros per year subdivided in the water bodies or in the torrents, as you see here, as I mentioned this. [Unintelligible] lies on the water board' first order, that means Danube and the [unintelligible] rivers like

So, even within these funds, we have to conduct our refurbishment of dykes. We see here the sum down below. It's about 1200 kilometers of dykes. We refurbished 240 kilometers of our dykes and we still have about 100 kilometers to either refurbish or to explore and therefore we estimated about 600 million euros that will be taken. Another program that was started was the [unintelligible] Program. This involved three countries -- Germany, Austria and Hungary. Each of these countries are related to the Danube and it was co-financed by the European Union and the aim was to create a vegetation management along the Danube. You see here the flood plain, there is a lot of vegetation and we have got no high discharge capacity -- this was all about simply shown by the sections here, the historical floods across in a system where dykes worse and little woody vegetation on the shoreline of the river and therefore, the flood discharge capacity within this flood planes were very high.

And, today it is like this woody vegetation is steep and between the woody vegetation the agricultural use in the form of corn fields dislocated. Though the water never rises, discharges and going down, the water never rises. And in future, we want to have something like a controlled vegetation with a higher discharge in this area. This is the vegetation management along the Danube clearing of critical existing

vegetation, the limitation of agricultural use. There are no corn fields in summer -- winter it is possible, but no corn fields in summer. And, you see here a little map downstream of the town of Staubing and you see all the red little things -- there, the woods had to be cleared. If you want to see more, you can read under [www.\[unintelligible\].org](http://www.[unintelligible].org). When we talk about woody vegetation, I think we have three topics. One is the woody vegetation to protect our river banks or our [unintelligible] for erosion or for shore protection and anywhere in the [unintelligible] section where woody vegetation occurs. We've got [unintelligible]. There are different topics but I will concentrate now on the woody vegetation in dykes and the effects on the stability of dykes.

We've got standards, they are quite strict as the USA for years, but nevertheless, we don't care I think and we have got 35% of our dyke length wooded on the water side and 50% on the landslide slope, so we've got about 1000 kilometers sloped with wood, trees or brushes in Bavaria. [Unintelligible] of the possibility we've got a lot of experience and we have a lot of assessment work to do. So, my fore-speaker, Michael Stout, mentioned all the negative effects of woody vegetation, so I will shortly summarize the positive effects. They've got natural reinforcement, they've got a drainage effect, they've got a protection against surface erosion and maybe or probably they have got something like a root cohesion. The negative effects that were mentioned several times before, but I think they are overwhelming. I mention here 11 and now too from experiences. So, we have got here two examples. On the left, you see a dyke. You have to trust me, there is anywhere a dyke and a nature protection zone, and on the right side you have got something like a trample pass.

I had to believe my professor who took this picture and you have to believe me. This is a dyke rest. There are some positive effects. You've got nice fauna, you've got nice flora, the landscape is very nice. I think it's nice, and you've got minimum cost for maintaining -- there's no maintaining. That's quite good. The negative -- you have not the

possibility to inspect it properly, you cannot conduct flood fighting measures, you cannot assess the stability of the dyke and you have got in this case the high cost for refurbishment. So, our statement is that this is not flood safe. We've got a lot of -- 1000 kilometers I told you. We've got a lot of examples for wooded dykes, the Alme River, [Munkefal] River, a smaller river. But, it began about 50 years ago or in the ancient years in the landscape, engineers started to plant poplars on the dyke toe, on the land dyke tow. Now, they have to remove it and refurbish the dyke again. So, this is from shortly -- taken pictures from a dyke located at the River Loisach and the right example you see, this is what I call the [unintelligible] to the nature authorities because it's a single tree, it's technically not okay, but this was a compromise to conduct the rehabilitation works. So, we have got started I think 30 years ago, a program to excavate trees on dykes.

Here we've got an example of a birch tree that was located on a dyke at the River Leche and the roots were extending all over the slope, all over the water side slope. The next example is a maple tree. The roots were extended in the top soil layer exceeding up to the water side and even exceeding down through a gravel layer to the fine sediment soil. A similar example is here shown by a poplar that even extends its roots toward the water side through the surface, the nature surface ceiling and even through the gravel layer, the gravel dyke body, to the fine sediment sand. We had a lot of dyke breaches because we had a lot of floods, and whether the dyke breaches were caused by trees or not, that is not clear. But, I think the trees or the tree roots in dykes were not able to stop them from breaching. The tree related damages -- here we see again a dyke breach. This picture always arise the question -- where has all the soil gone? There are only roots left. The next picture you see a wind throw at the water side and there was some over-topping, a local over-topping of the dyke and here you see an over-topped dyke with some trees on the crest. Here you have to trust me again. Here are some wind throw examples, here left of the land side dyke toe, [unintelligible] thrown by

wind. On the right side this is a roadway example -- of a few poplars that were thrown by wind. Even at the land side dyke toe in 1999, after the flood took place in 1999, a row of poplars were thrown even by wind forces. So, more damages. Perhaps you see here on the left, this was the over-topped dyke with the trees on the crest.

Even here you see a cable in the crest zone which is not allowed standard, but it is very easy to use a dyke because it is the only way that goes straight through the city or through the town and on the right side you see some top soil layer that's sliding, maybe caused by lack of rooting. So, this is on the right -- we have got an example where a tree root is sticking in the dyke and it's rotting. Maybe it's still alive -- I don't know -- but it's rotting, and when you look at it very close, you see that stones of I think a diameter of one or two centimeters are eroded through this hole. So, I think the question is clear that rotting roots may provoke some erosion or not. This is an example here for it. But for German standards, we have got the National Standard Organization. This is the basic team only referring to flood protection dykes at the rivers and it was called 19,712 and it is now actually revised and will be finished I think in five years. The special thing on this standard is that normally in German standards they are always very technical content. They've got only technical content, but here, even vegetation issues are contained. And we've got the command on these standards, the standards itself has got about 30 pages.

The command will have about 150 pages, where we regard all the scientific things and all of the experiences. Then we've got the old commands and then we have got technical specification or guidelines especially dealing with vegetation on dykes. We have got other guidelines referring to vegetation on river shores, vegetation along rivers, vegetation to erosion protection, whatever. But, this is only a technical guide for vegetational dykes. Besides, I have to mention that we even have got guidelines for digging animal on dykes regarding beaver, nutria or muskrat. Okay, then we've got different guidelines even very special, like

referring to dealings in dykes, dealings in water resource management and [unintelligible]. But, there is one big cost or one big force that is only bad for you because you cannot talk German -- we have no English translation for that and so we can look at your standards report and get all the information you have researched or you gained, but you cannot -- even the Dutch succeeded in translating the standards or some of the standards and so we can look. I actually do not know why we do not translate it, but I think there is not enough time besides work. So, what is in the standards?

Here, we see a dyke section -- how it should be, the minimum specifications. The dyke crest should be wider or larger than 3 meters. The inclination of this load should be 1 to 3 and we have got a berm on the land side and on this berm there should be a roadway that should be higher than the [unintelligible] and we have got the specifications for compaction, for permeability of soils and on and on and on. But, we have even some specific specifications for vegetation on dykes. So, this is a typical dyke system. We've got a berm, we've got a 3 meter crest and normally, the brushes or woody vegetation is only allowed in a distance of 5 meters from the dyke toe. This is 5 meters and large trees are allowed 10 meters from the dyke toe. When you have got here, like I've drawn here, an oversized addition to the dyke body, you can there plant something like small brushes or something like that. But, the lower third of the land side slope has to be clear for inspection because somewhere there should be the exit of the vegetation and even the water side slope should be free from woody vegetation. What we care a lot for is grass vegetation because this is our erosion protection.

But, you have the need to differ from the standards, landscape issues, natural issues, population, and then you have to think about what can we do not directly according to the standards, but with the same security level. And, we reinvented some new vegetation concepts regarding vegetation types of trees or certain protection measures. You see here the

protection measures are very simple -- none. Land side oversized section, land side water side oversized section and those are [unintelligible] aesthetic function in the middle of the dyke. Then, you have to justify the trees or the woody vegetation. We are here introduced to risk class 1-4. Risk class 1 is very risky, so you have got here your Ash Chestnut or Common English Oak and risk class 4 is not very risky. Those are the little brushes like thorn or rock berry. Then you have to subdivide the dyke section in different zones as you did in your standards. We have got a little more zone, but the land side zone subdivided into 6 zones and water side zone into 5 zones and the crest zone and regarding to the protection measures, you can allow some trees where you want it. When we see line 1, this is the normal dyke standards referring to the standards. There is no vegetation within 5 meters distance, 5 meters [unintelligible], but when you see line 4 with the aesthetic feeling element, you can even plant some little brushes on the water side and the land side slope.

There are a few hints that must be given when you are using that scheme. There are 11. I here quoted just 8 or 7 and there's always some from [unintelligible] intrusion of roots to [unintelligible] must be excluded, but I will not [unintelligible] this topic. So, maintenance and inspection is very hotly discussed in Germany because we've got 1000 kilometers with woody vegetation, so we cannot know it and we cannot do nothing with that. But, in the standards it is written flood protection dykes have to be maintained in such a way that their stability can be permanently guaranteed. So, when warm grounds grow digging a hole in your dykes, is then the stability permanently guaranteed? So, we concentrate our maintenance when we have [unintelligible] grass sort to keep the stems, to keep this mowed, and that our erosion protection is ensured, and we have to do it minimum once a year. Five minutes? are you sure? I'm too long, so I have to hurry up and we have to have a dyke book, we have to have a yearly status report, where we have to write down experience during flooding, for example. So, what I have to mention is what I found in some paper of text passage out of a law 700 BC. I will read it for you.

If somebody neglects to keep his dyke in good shape and if this dyke fails and all has flooded, then that one who was responsible for this [unintelligible] shall be sold for money and the money shall be taken to compensate the corn that was lost to flooding.

So, I think a few of you guys are quite glad that we are living in this age. Even like in Bavaria, they are very glad too. So, I have to hurry. The structural solution -- you can read it later on my presentation -- we only just want to avoid the seepage through the rooted soil. We use root barriers, we use non-corrosive soils, we use [unintelligible] filling, but you know it on your own. This is a [unintelligible] and you can allow some trees on the slopes or not and these are our typical sheet pile fillings that are applied in Bavaria: there are some milled cut off boards, some boards -- cut off boards, [unintelligible] and a thin wall and the planting of the lower three methods is that you can reinforce it with a [unintelligible] and the other two are the cut off boards that you can reinforce it. So, you see here reinforced [unintelligible] wall that you have taken from sheet pile. So, for an oversized dyke with a root barrier or some single tree protection measure. Like you see here, left is a dyke within the urban area of Munich. Left there is a reinforced milled slurry wall in it and right is the single protection of a tree. So, research. We research a lot of salts. We don't even research on bushes or something like that or woody vegetation. That is done actually by the University of Vienna. They try to protect the dykes in case of overtopping with bushes or trees and I'm very looking to their results. I think I can imagine what they will be and we are researching some salts or some crest layers that are reinforced [unintelligible]. We will conduct the last test next week after my jet lag.

Then, we researched the [unintelligible] hydraulic behavior of rooted soil. You see here the [unintelligible] potential or the saturation and you see a few of these section curves of soils and what we researched -- what we found out is that with rooted top soil that has protection behavior of silt or

loam but the permeability of sand. So, maybe for [unintelligible] page calculations can be worthy. Then, windthrow -- I leave this out and go to the root system of filling elements. We have researched or assessed 6 filling elements -- natural clay silt filling, [unintelligible] the clay liner, sheet pile wool, cut off wool, mitt, thin wool and reassessed it by 5 criterion -- clay systems, protection measures, chemical [unintelligible] systems, imperfections, and the result is in here -- that the surface ceilings are quite in danger by rooting except you apply some protection measures and the [unintelligible] ceilings are quite okay. They are quite good for system except the thin wall that is really very thin, maybe judged for the assessed case. So, thank you for your attention.