A report on the water problems, its causes, solutions and human struggle against it as it was experienced during the Holland and Italy trip

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Preface

The eight members' delegation team visited Holland from 4th October 2002 to 8th October 2002. During this visit Dr.

Frans van de Ven, an official of the RIZA (Ministry of Water Management) who simultaneously holds post of Associate Professor of the Department of Civil Engineering, Delft University, organized a fieldtrip in and around Amsterdam, Lake Markerwaard, Lake IJsselmeer, some polders on the way and to the coast of North Sea.

In the subsequent days a lecture session was organized by RIZA at Bavariastad those focused on the water management issues, both the technical aspects of the causes of problems and their solutions regarding the water quantity and quality and also the environmental issues.

On the third day we had presentations by Professor Pieter Huisman and Ms. Karin de Brujin of Delft University on the historical aspects of land subsidence and sea level rise and the Dutch struggle to protect their land from aggression both by the sea and rivers, and the future course of water management.

After this intriguing discussion we visited the two parts of the Delta Project, the Haarvig Sluices and the storm surge barrier near Rotterdam.

In Italy, we visited the historically well-known "sinking" city, Venice, 11th October, where a lecture was organized "on the problems of the Venice lagoon and the human interventions to protect the land and fight against the invading water" by Dr. Giovanni Cecconi at Consorzio Venezia Nuova, Venice.

Here is the detailed report on what was told and an account of the enthusiastic discussion in the chronological order of this whole trip.

"North Amsterdam/ North Holland tour with Dr. Frans van de Ven" 6th Oct. 2002

Points of particular interest for today's tour include some polders and UN cultural heritage area. The interesting difference between the lowland cities like Amsterdam and Saga in Japan is that, Saga has many more canals than Amsterdam, but they are all narrower than what is there in Amsterdam or other parts of Holland. This is because historically the canals in Amsterdam are used for ways of transportation, hence there was need to make wider canals for the ships, which was not so in case of Saga. Amsterdam canal is connected with lake near the central station that keeps the water level of the city at a particular height. This lake is, in turn connected by the channel to North Sea. There is a huge pumping station at the seacoast that controls the water level. By this way, they can keep away any chances of damages during high water. Moreover, if Amsterdam has surplus of water, to maintain both surface and ground water level this water can be discharged to lake IJsselmeer and lake Markerwaard, which is connected by routes to the open sea further north. At Amsterdam this is extremely needed to control both surface water and groundwater to keep the buildings from getting damaged. As most of the Amsterdam is having peaty soil, there is high vulnerability to land subsidence. To get rid of this problem, the builders need to put wooden piles in the ground. Now, if the groundwater level goes down these wooden piles become dry and start to rot, result in collapsing of the building. This is the reason why one needs to control the water level precisely in this area.

The area on the right side of the road is earmarked for a recent project somewhat similar to what is happening in the Tokyo Bay near Yokohama area. The area was filled with sand and made into a new township in such a way so that the new ground can bear the pressure of the buildings, so called floating township. This is a project partially of the central government and partially financed by the local government and the municipality of the city, Amsterdam. This is the first kind of experiment in Holland to build township on a floating land.

Next was a visit to a place famously called polder land in Holland. In all these areas there are 20-30 cm of the level fluctuation in the surface water. So there are much areas of surface water. But in Holland this is no problem to create sufficient amount of storage in the urban areas, as it is more popular among the Dutch people to have a house with some view of water body in front. Water view in the landscape is therefore more accepted as a quality element. These areas are normally more expensive than others. But this is not so in Japan. Normally all the water bodies are out of the city area in Japan.

One of the important landscapes of the Netherlands is the lowland made up of silt and peat. The water level is very shallow in these parts, may be 30-40 cm below the surface. Now if there is decrease in the water level, these peats start oxidizing and compaction of the layers causes land subsidence, which puts these lands further 30-40 cm below the sea level. Here, in the landscape one can see both high and low dikes, in fact there are many dikes present in this area. Before 1932, now lake IJsselmeer was the part of the Zuiderzee (means Southern Sea). With high and low tides, surface water fluctuated in these areas. Dikes here were put to save the hinterland from submergence. The salt water of the sea destroys the grass of these lowlands and it takes 4-5 years to grow new grass. All these lowlands are used for diary farming as one can see long stretches of green meadows with cows and sheeps. So these dikes here are still left even after closing the sea and formation of the lake IJsselmeer.

Lake IJsselmeer has a pumping station next to it. The lake's water depth is 4-5 meters, so this lake is now used for sailing boats for shipping goods, both by the Dutch and Germans. Boat manufacturing, repairing business and recreation, like yachting are the main business now. The polder area to the south of lake IJsselmeer is a reclaimed land after 1932. The sea mouth in the north of the southern sea was closed. There were a lot of environmental changes and natural landscape and environment was lost. In places, reclaimed lands were developed. But today with stricter environmental considerations it's difficult to propose further development of reclaimed lands. 20 years before there was a plan to reclaim the area what is now known lake Makerwaard, but it was not done. Though the areas around that part are growing with the growth of Amsterdam city and nearby urban areas.

The difference between the Japanese approach and the Dutch approach to taking measures during high water is that, in Holland they are trying to increase the area of retention, or storage capacity. In the time of excess water, these areas will be used to keep the extra water for some time and then it can be pumped out. Whereas, in Japan, there is no increase of storage capacity, but Japanese policy tries to increase the pumping capacity. Ultimately Japanese policy will not win. Because, when there will be more rainfall, even a double amount of rainfall might need a tremendous amount of pumping capacity which is beyond what the present technology can offer. So the solution is not the increase of pumping capacity but may be the increase of storage capacity. From this point of view, having floating town section, as is being done in Holland and also in Japan (like near Tokyo Bay or places like that), may be the plausible solution. The climate (rainfall etc) in these two countries is also different. In Holland, water can not be stored in the grasslands as the grass doesn't allow long time inundation, so ditches and underground water are the only places to store water, whereas in the places like Japan where you have paddy fields, it is possible to store 5cm of water in these paddy fields. So in Netherlands, more areas of ditches are needed.

Morphologically, in the lowlands (with silty and peaty soils) the level difference between the surface water flows along the ditches and the surface is very small, less than a meter, whether that in Japan is much larger. At Kyushu, the places with severe land subsidence still have a difference of 2-3 meters. In Holland the land level is maintained so to reduce the chances of subsidence.

The ditches in the peaty area are the property of the farmers. They are responsible for maintenance of these ditches including the cleaning. Every year the inspectors from water boards come and check the condition of the ditches.

Along the beach there are natural sand dunes in parts and in parts dike has been made to resist submergence during high water levels. The natural sand dunes are protected by some special kind of grass. This grass is salt resistant and they keep the sand grains and dune stable. Also new sand gets deposited in between the grass and thus maintaining the height of these sand dunes.

On 7th October, colleagues of Dr. Frans in RIZA organized a seminar session at Bavariastaad.

Water Management in the 21st Century (WM21). 7th October 2002

Reasoning on the water system for the commission WM21.

Dr. Frans Claessen head of RIZA

For the water system, there is demand and supply. Water system management is connected to the citizens, societal system, politics and special interest groups by communication, administration, organization and financial affairs.

General points of water demand and supply: Development of water supply depends on factors like how large the sea level rise as is the present trend or the calculated forecast of authorities like IPCC. Another factor is the increase of fluctuations in the river discharges, which might be more than at present and as well less at times. Increase in the fluctuation and intensity of precipitation as can be applicable in Holland leads to the development of water supply. The amount of land subsidence is also related to the water supply. On the other hand, the development of the water demands depends on the changes in the natural areas, changes in urbanization, changes in agriculture and changes in other forms of land use.

Then there are some basic assumptions for the commission, first the climatic changes. One has to look at the parameters like change of temperature and also the precipitation minus river transport (P-E). We look at the resources, as IPCC and transform the data as applicable to Holland, with the flows of the river Rhine and Meuse. Also, precipi-tation and discharges for optimum situations like extreme flood is evaluated. We make an estimation of the sea level rise in accordance with the world sea level rise, also relative sea level rise incorporating land subsidence.

As precise scientific prediction is not possible we make some "what if" situation, i.e. we think of some situations, may be extreme and try to understand what will happen in those respective scenarios. The IPCC prediction for global changes at 2100 is the average temperature increase of 1 to 3.5ºC (this is a figure as estimated in 1999, now it has been fixed to 4.8ºC). These data are taken and extrapolated in the regional situation of Holland (KNMI=National Climatological Interpolations) in the national scale and in the river basin scales of the Rhine and the Meuse basin. In this process, we assume that there will be no change in the large circulation patterns of the global climate. This is an important assumption as this can also change and then the calculations become incorrect. So our calculation based on two time changes, one in the middle of the century at 2050 (+0.5ºC to +2ºC) and the other at the end of the century at 2100 (+1ºC to +4ºC).

Now, the external driving forces (climate, Rhine discharge, sea level and land subsidence) can be divided into 3 scenarios. One is at present trend where the temperature rise is considered to be +1ºC and the Rhine discharge at the rate of 16,000m^3/s (maximum discharge one in the 12 to 15 years, present level is 15,000) and a corresponding sea level rise coupled with land subsidence of +20cm. This is the normal trend at this moment by extrapolating the external driving forces. In a worse situation, with increased greenhouse effects, the temperature increase is calculated as +2ºC, 18,000m^3/s of Rhine water discharge and

+60cm of sea level rise. But in the end of this century, the extreme situation might produce +4ºC and discharge of Rhine at 20,000m^3/s and +110cm of sea level rise. But as far as the present capacity of Rhine is concerned 18,000m^3/s is the maximum limit and in case more discharge than that occurs Germany and Swiss part will be out of the equilibrium and also some part of Holland will be inundated.
Land subsidence due to mining and gas-oil extraction leaves many areas in the north. In the Flevoland area subsidence occurs more than 60cm due to settling of the recent sea deposits (soils and clay). In the southeastern side of the country it is a high land, so the whole geomorphology is slightly tilted towards west.

Conclusions of the analysis of the commission WM21: Water management system are often found to be not proper, surely after the climatic change it won't work in the present level. As in many other countries, water management, water policy and research are split up at different scales and different state departments, i.e. there is no effective coordination. Hence, another water policy approach is a must. Too low awareness of costs and benefits, insufficient care of citizens and the political system leads to little support for effective and sustainable water management. Better information about the threats and opportunities of water and more direct involvement of the common people in water management affairs can make the situation better.
Commission brings about some new water policy, which lies on some principles that includes a responsible government for the societal system whereas, for the water system, a liable, sustainable and manageable water management system is needed. No further loss of "space for water" and an integrated water basin approach are also extremely important.
The commission came with marking 17 new water basins in whole of the country. For these, three principles are formulated, one is to retain and store water temporarily, next is to provide room for water and after attaining these two there should be a look for the multiple use of land. The three strategies in this regard are "to retain", "to store" and "to discharge".
Now, the preference of solutions firstly demands redesign the regional planning of rural and urban areas and then if possible, anticipate via water level management, make more rooms for water storage. If there is no alternative go for the large-scale technical interventions. And always we should control the management of risk.
Recommendations of the commission: For another water policy, one national plan for the entire national water system is needed. Adjust the flood risk standards for the rivers, lake IJsselmeer and the coast, settling up the risk standards for regional water systems (regulations for insurance and damage compensation), no shifting of the problems to downstream areas and no building in the floodplains of the river Rhine, Meuse and lake IJsselmeer are the other recommendations.
When considering the cost and benefits of this new strategies, more room for water might seem more expensive in short term but in long term it is beneficial by less flood risk, more flexibility of the system, sustainable and less drought damages to the nature and agriculture and betterment of the environmental quality of the country.
Now the action plans as formulated by WM21 commission that includes formation of a national platform for water debates, communication strategy, research program on integrated water management, carrying out water test and producing water policy documents. National administrative agreement involving all the agencies, like the government, citizens, provinces, water boards (may be formed by next year). National plan for the primary water systems is also needed.
There is need to think about the effective drainage patterns of the river water, like that of Rhine in the delta region. When there is discharge of 16,000-18,000m^3/s there is a need to divide the water flow in two different channels dividing them efficiently. The present plan vows for dividing the flows of the main stream into three parts. Plans are there to coastal flood defense, regional water basin programs, and elaboration of the risk standards including the insurance in case of any damage.
The awareness program for the common people is not satisfactory at the present level. We use television, newspaper and other special interest groups to activate an awareness program. But the results are not yet good. Still people think that the problem is for the future and not an immediate problem. Already most of the lands are below the sea level, somewhere 4-5 meters. So people have become accustomed with this situation and increase of another meter or so, is not considered as a threat that much. There are political problems and problems between the different regions.

"Flexibility in the safety strategy for the Dutch rivers : a policy analyses"

Dr. Arthur Kors, Senior Hydrologist

In the past we used to raise the dikes with increase in the water level, but now there are problems and for which we have to stop rising any further the dikes and instead look for some new strategies.
There are three main objectives. Interaction between the upstream and downstream parts of the river system, as when one thinks of any measures the interaction between these two have to be considered at first. While considering the special measurements the distribution of discharges over the three Rhine branches is an important factor. Moreover, as the Netherlands is a country with places of dense population, the reservations of space for any measures that would be taken is needed.
The two main tasks are the hydraulic and spatial tasks. Hydraulic task include those that take care of the projected increase of the river water volume (Rhine: 3,000m^3/s extra i.e. 19% and Meuse: 1,200m^3/s i.e. 21% extra) while considering dike heights etc. There is a sea level rise of 0.6 m and also 0.5 m accretion in the riverbed in Western Netherlands. All these have to take care of. Spatial tasks include the maintenance of existing qualities and development of new qualities. Now, these qualities do not only include ecological and landscape qualities, there are points of economical, social and cultural potentials in this country and also many emotional values-impregnated factors are there among the people. There are small-scale measures on the riverbed that should be considered, e.g., removing the obstacles from the riverbed, excavating the floodplains and shifting the dykes in places to get an increased volume of water. Excavation of not only the floodplains, the riverbed is also worth

considering, as the accretion due to sea level rise in the western Netherlands is a problem. Large-scale measures outside the riverbed can be considered in terms of large-scale shift of the dikes, bypassing the river water through new branches ("green rivers") along the river around some cities. And making large-scale retention areas are also important. As future potential measures to tackle with the greater water volume, the possible retention areas are marked on all along the river channels. Making new bypasses are hydrologically possible more towards the delta areas and near the lake IJsselmeer (in case of the Rhine), whereas the dykes can be put on the upstream side of the river. Now, all these options applicable to all the areas but we are now evaluating which measure or combination is the best suited as spatial quality option. Along the IJsselmeer there are more areas of ecological and cultural values, which we want to keep. Another option is the management of the water system (WM21) keeping in mind the regional water system as 95% of the discharge comes from Germany, Swiss and France and also by the large scale measures as mentioned before. Another point is the cost-effectiveness of any measure, finding out the cheapest options.

Evaluation of the measures is done by the evaluation of social and economic cost-benefit calculations. There are many effects that we couldn't quantify in terms of money and these are done on more qualitative ways. The conclusion is that small-scale measures don't provide results in long run. And in the long run the large-scale measurements seem to be more attractive. Upstream retention is very attractive as the 4 retention areas marked near the upstream areas solve the half of the river discharge problems. But there are political problems also, as all these areas are situated in a small province and the people living there ask why they should suffer for the profit of the people of the rest of the country. The distribution over the branches of the Rhine should change at high discharge time. There are too many parameters on which the calculation of the actual water distribution through the branches depends like the decision on the retention areas and so on. But in future there should be a change of the discharge distribution along the branches, for sure.

Question: What is about the participation of common people, the awareness efforts among them and taking care of their ideas and views?

Answer: It is difficult to deal with the ordinary people, as they have different and all sorts of ideas all of those are hard to accommodate.

Dr. Frans: The system is layered, and in the innermost layer of the circle there are the government bodies, the decision making one. The outer second layer comprises with the different stakeholders, working groups, special interest groups including the nature conservationist who are there in all the committees towards the decision-making and the third outer layer forms the common people who have their voices through their representatives both in the government and also in the different interest groups. And the most important is to communication between these different levels. The media, as an example plays a very important role. There is a very delicate balance while dealing these issues. If the decision-making process gets too publicized, immediately there will be many problems and resistance from different interest groups, citizens. So it is difficult. A small article on the retention areas may produce huge public resistance as everyone is against it.

Somewhat same situation prevails as in Sapporo. Sapporo is under a threat of couple of meters of flood but the people are not properly even aware of the importance of taking measures. More than the citizens the stakeholders and the special interest groups are very aware of the fact and they always contribute in the process of decision making quite positively most of the times. We have to fight with them and we believe that they contribute in the system knowing all the pros and cons of the situation regarding the water problems.

Comment by Dr. Frans

Dyke levels are designed in Japan as once in 150 years while that in Holland is once in every 1250 years so the protection level is much lower in Holland then.

For natural disasters whether there are any insurance and government compensation. For the individual property in Japan, government doesn't pay for the private property loss only the road reconstruction and other environmental reconstructions are supported by the government. In Holland, government pays to the public in case of any disaster. So additional amount goes from the national budget to compensate the people, hence the decision making process is quite intensive and important.

"Development of new water policy for lake IJsselmeer"

Dr. Arnold Hebbink, Hydrologist

As the history tells, the lake IJsselmeer was part of an inland sea 100 years back. In 1965 there was a huge sea storm from the North Sea and as a result a large number of the dikes burst and caused huge damage to property and human lives. After that government had decided to make a barrier and separate the lake IJsselmeer from the main sea. In this process lake water changed from salt water to fresh water and new lands could be reclaimed, as four main polders in the inland sides of the lake IJsselmeer. River IJssel brings most of the water to the lake and there is North Sea canal to the sea. There are some sluices and pumping stations and water levels can be maintained by the canals and the sluices at the mouth of the lake IJsselmeer. The canals always have lower water level so it is possible to discharge water through these canals to the open sea. A border lake was created along the new polder/reclaimed land. This is due to that while making these polders there was a drop of groundwater level, not only in the polders but also surrounding old lands and on the northeastern side some of the older agricultural land suffered from this new land proclamation. So to supply water in these areas the lake was formed.

With sea level changes, the target water level in lake IJsselmeer varies from –1 to +1m. The winter level (-40cm than the mean sea level) is lower than that in the summer. Maintaining the target level is very difficult. In December-January of 1988-89 there was a rise of water level of 40 cm than the target level and in 1998 it even went up to 1m higher than the target level. In summer, there is less precipitation and higher evaporation rates provide less amount of discharge through the river IJssel. In recent years problem of saltwater seepage occurred in the coastal areas due to drop of discharges through the rivers. For that we have planned some canals on the northeast to supply water from lake IJsselmeer to these areas to flush out saline water. To maintain our target water level in the lake, the sea level rise has also to be taken in to consideration. The study here assumes a rise of 1m at 2100 year with a temperature rise of 4ºC. With the water climate change, three points have to be considered, the sea level rise that increases the upward seepage and consequently the sluices will have discharge problems (it won't be possible to discharge water with a increased seepage), river discharge increase in winter and it decreases in the summer. These last two points lead to problems due to small storage capacity and the problems with the water divisions.

Project WIN: Water Management in the northern part of Netherlands. The objective is the integrated consideration of the future water quantity management (quality is not considered in this project) and the necessary measures. Two tools are used: collaborative planning process (CPP) including all the representatives of political parties, recreation industries, agriculture and all others who are involved in these areas and making a decision support system (DSS) that provides an integrated knowledge to support the process. In this project we interview all the representatives of different interest groups and collect data. It was first started in 1998 and in the last 4 years we have enough data to put in a DSS system called WINBOS 2.0. This decision support system is necessary because this is a very complicated problem, as many stakeholders are involved in it. To quantify the problem this support system is helpful and after initial years there were enough data available to make such system. Moreover, this kind of system is very popular among common people and is easy to convince the problems.

The problems are as follows, the dykes are not high enough and the water is not enough for supply to the agriculture. During the period of the increased level of water in the canals, shipping through these canals are affected as high water level hinders the smooth shipping under the bridges, they have to be restructured. Now, the system works in a way that there is a user interface where if any question is put, 25 to 30 models based on hydrology, ecology etc. consider various functions like safety, water supply, discharge, nature, shipping drinking water, fishery, recreation, agriculture and landscape before finally go through all the data for an answer.

The project finally eyes for a decision towards the scenario at the year 2100. There will be climate change, regional water discharge and water supply can be changed and also the chloride concentration of water of the river Rhine might change. This might directly affect the drinking water supply system. The measures might be considered to change the target levels, putting extra sluices and making banks to protect the dykes.

The WINBOS system has three kinds of people in the system; the users, the experts who have the technical data and the knowledge, finally there are people (IT) who make a model including all the data. The problems associated with the area around lake IJsselmeer include a water level rise of 1m at the end of the century, only dykes have to be heightened 1.5mts more than the present levels to mitigate safety against flooding. Moreover, another major problem is the discharge facilities. At this moment there are sluices and pumping stations. But with increase of 80 cm of sea level means that discharges through the sluices will be almost impossible and only to depend on the pumping stations. Huge pumping stations will be needed to discharge nearly 100% of the water. These comprise the exploration phase of WINBOS where we explored all the problems. In 1999, we started the next phase of the WINBOS, the creative phase, where we interacted with the common people try to convince them the problems and ask for their views. The parameters, in case of the recreation sector came out as recreation at the banks, inundation frequencies and the vegetation in the shallow water of the lake. As the vegetation increases in the water, there are problems of boating and recreation boating. Ecological problems also have to be taken care of as separate parameters. As far as the water levels are concerned, if we increase the water level in summer and gradually bring down to winter, there are problems of dyke safety. The optimum level rise is not yet properly known. The fishing industries have problems as the fishes have to pass our sluices and that depend on the water level.

After investigating the measures we enter into the strategic phase. There are main questions raised during this phase as follows:

Along with the safety of the places around the lake, safety of the border lake is very important, we included a separate model for this lake. Safety of the rivers IJssel and Vecht. The water quality problems.

Canal levels are changed or not. If not, the canals in and around Amsterdam will have problems with the boating as they can't pass through.

Last question is the problem of the wind. Wind is a very important factor in Holland. Across the lake IJsselmeer there is a change of nearly 2 m of wind velocity. In Japan also all the coastal areas suffer heavily by the wind effect. The areas at the mouth of the rivers come into the lake are highly at risk as they suffer both from the problems related to the river discharge and the sea storms. The southeastern portion of the lake IJsselmeer face directly to the sea and hence the sea storms directly hit these areas.

What is needed as policy making is to make bigger pumping stations (the biggest pump in Holland 165m^3/s) to 2,100m^3/sec, vertical storage of water and horizontal storage of water. The result will follow by combining all of these.

Outcome of WINBOS: Stakeholders feel that they are involved and aware of the common problems, effects of several strategies are clear and finally the stakeholders have confidence in the output of WINBOS. Expert knowledge and public knowledge work together and that is very important. Talking to people, communicating with them, getting responses from them was found to be very effective.

"Delta-Works revisited: Ecological restoration perspectives for Volkerak-Zoomeer"

Dr. Marcel Tosserams

At 1000AD, first human settlements came to be in what is now Netherlands. By 1250, dykes and polders have been started to build.

While at 1950, still there were all the channels in the delta area were connected to the sea. Then at 1953, there was a huge sea storm surge that took 1,850 lives and flooded many places. The government had started the first stage of the Delta-Works where 50 infrastructural works were taken place. Harwig dam in the northern part is a huge sluice that controls the water during high and low tide. Another big work was the storm surge barrier in the eastern Scheldt. By these works a new situation has been developed in the delta region. The delta was fragmented and different separate systems of freshwater, brackish water and salt marshes were developed that was not there, earlier. Now the question is that with all these measures, the safety levels are heightened but what about the ecology of the delta. Sharp boundaries between fresh and salt waters, nutrient-rich and poor regions, water and land areas in terms of morphology are the new development in this area. There was reduced migration of organisms. Loss of hydro- and morpho-dynamics and loss of estuarine habitat and species are major ecological effects of the Delta-Works.

The estuarine ecosystem had been changed (in one year from 1986-1987) to a freshwater system in the lake Volkarekmeer and Zoommer artificially by separating the natural channels affecting its interaction with the agriculture around this place.

The water quality in the lakes changed very sharply from tidal to fresh water, the shore erosion had been stopped, initially the transparency in the lake water was very good (up to 4-6m at places) but later decreased, phosphates and other chemicals from the adjoining agricultural lands changed the chemistry of this stagnant water system, blue-green algae developed very fast making the system more to a eutrophic one and the underwater vegetation went down in amount also. So this kind of total cut-off from the natural channel is found now as a very short term and not very advantageous.

So the long-term plans are underway where the restoration of the lake to its original river channel system connecting the eastern and western Scheldt is planned. The restoration of the ecosystem to the near-original by removing the barrier around the lakes are considered as well as the ways to defend from the storm water intrusion by making channel bifurcation and connecting some channels to make new pathways.

"Dike level and freeboard level assessment methods"

Dr. Herbert Berger

Safety level in the Netherlands: A vast part of the country is vulnerable to flooding, both for river floods and storm surges from the sea and parts where both are causes. There are lots of dikes but still it is not safe. Every few kilometers of the dikes got burst every year as shown from the dike along a contributory of Rhine. During high water level, dike bursts are caused by both pressure of excess water and bad dike maintenance, some times people of one side of the river does this so that it doesn't come to their side. The dike safety levels are variable in different parts of the country depending on the different level of danger, like the coastal areas storm surge and salt water intrusion cause more damage than the inland river sides where floods and consequent dike burst cause less damage to human lives and properties. Moreover, in comparison to the river floods, storm surges are sudden and don't give much chances to evacuation. Hence, the dikes in the coastal region have a safety level of 1/10,000 years whereas the inland areas have 1/1250 years. In the south Holland, along the river Meuse, there is not much danger and hence calculated to be zero safety level. Safety level of dikes as 1/1250 years means the chance of dike burst in each year is 1/1250 (6% of a dike lifetime of 80 years). So it is not true that the dike once built will be burst after 1250 years but it has 1/1250 times chance to get burst this year also. By law, the dikes are tested every 5 years. Dikes must stand the hydraulic boundary conditions. In case of insufficiency the reinforcement is necessary.

For Rhine and Meuse rivers, the total catchment areas are 185,000km^2 and 35,000km^2, lengths are 1320km and 905km, mean discharges are 2300m^3/s and 230 m^3/s, maximum discharges experienced are 1,2000m^3/s and 2,870m^3/s during the 1995 flood whereas the design discharges are 15,000m^3/s and 3,550m^3/s, respectively. Recently both these design water levels have been increased due to very critical condition of the water level as against the dikes around the channels that was experienced during the 1995 flood. The crest levels of the dikes are determined after the determination of the design discharge, design water levels, influence of the wind. Design discharge is calculated in statistical way from the data of series of the measured discharges at the borders, homogenization of the series and then by the statistical extrapolation (Gumbelverdeling distribution). Regression lines are drawn from the measured values of discharges to calculate the design discharge. Recent developments to enhance the calculation and regression models include the rainfall generator (from the known data of rainfall for a period of say 100 years and then generate the pattern for the 1000 years) that gives better estimation and also include Bayesian analysis where uncertainties of parameters are taken care of. But still there are great uncertainties in the range of 3,000m^3/s where the design discharge is 16,000m^3/s.

Now, the calculations of dike levels around the lakes are, on the other hand, depends on the possible hazards, like high water level and high waves. Origin of the hazards is considered due to the mean lake water level and wind strength and direction. When plotted the isolines of hydraulic load (or same necessary dike level) in a wind speed vs. lake level, several combinations of these two can be possible for a same dike level. Necessary data to calculate the required crest level height include the calculations of the water level and waves, profile of the dike (width vs. height), the influence of the area just before the dike, wave run-up formula and design frequency etc.

So there are some differences between the dike level calculations between those of the rivers and lakes. For rivers, design discharge (statistical extrapolation) and the proper hydraulic model are needed whereas, for the lakes many combinations result in the same hydraulic load also a hydraulic model and wind model are necessary and a probabilistic method is the

need. Now, to design of the reinforcement of dike new ideas and technical developments about discharges, wind speed, bottom levels etc are needed. For rivers, the policy is now to reduce the design water levels and the studies are carried out for increased design discharge (18,000m^3/s instead of 16,000m^3/s after the IPCC recommendations). For sea or coastal dikes and storm surge barriers 60cm sea level rise per century is taken in to consideration. Moreover, for future reinforcement the space reservation is necessary, like 85cm/century + 10% for the wind.
For the dikes, there should be at least 50 cm gap between the official water level and the dike level. And one has to do two tests, one at the normal level test and the 50cm tests to incorporate the uncertainties.

Visit to The Department of Civil Engineering, Delft University: 8th October 2002
Prof. Pieter Huisman

History of the development of the struggle against water and subsiding land way back to several centuries ago. 10,000 years ago large part of the North Sea was dry. In course of time sea level started rising sometimes half a meter in a century. As also these days IPCC forecast the sea level rise, here in Netherlands, we had experienced the sea level rise long back. Due to this sea level rise there were formations of transgressed sediments, peat first and then coarser grains sediment on it, hence there is a building up of the sediment layers. In the beginning of this era, the coastal area that was covered by peat and sediments had been influenced by the sea and large parts of these lands were under the seawater. In 1500 AD large part of the western Netherlands became prone to the sea and about a century ago, an inland sea, the Zuiderzee was formed. This natural development of sea level rise and subsidence was intervened by people for different reasons. At the beginning, about 1000 years ago there was an expansion of population. To feed all these people, there was a need to increase the agricultural land areas. This was achieved by digging ditches to bring down the water table. But as a result, the peaty soil released water and got compacted causing wide scale land subsidence. To keep the land good for the agriculture they had to lower the water table further. So they started a process of land subsidence. By two centuries, it became necessary to protect the land from flooding. To do so, they built dikes. The dikes were raised by the local communities to protect themselves. Each farmer had to maintain his part of the dike. But these dikes had weak spots. Due to the design defects, these dikes burst quite often and the person on whose property this happened they were forced to leave the land. And the local community selected another person who could save the dikes. So the interest of the community and the society was upheld before the individuals. But the land was still subsiding, so about 700 years before people started to make dams on the rivers, which crossed through the peat. The sluices were built to control the water. Amsterdam on the river Amstel was one of such dams at that time. But local communities separately couldn't maintain the dams, dikes and sluices and there was a need to do it on a regional basis over a large area. So the local communities elected representatives from them and formed the water boards. These water boards soon became very important organization in this country, self-organizing and fund generating. But the election process in the water boards was not based on "one man one vote" but on the scale of interest, area involved and the payment. If you have a larger interest that is for a large land area, you pay more money to the water boards and your voice is strong. But this is the oldest democratic system in the Netherlands. In a long span, this can be seen as "started to dig ditches and ended up with a delta situation". With passing time, the land was still subsiding and a situation occurred where the land level and the sea level became same. About 500 years ago it was no longer possible to get rid of water anymore and then we had started to build the inner embankments behind the dikes, called polders. From these polder the water was artificially removed and brought on the former river course and then to the sea. For this windmills were introduced. The windmills with rotatable tops actually saved this country. With these windmills and dike techniques, it was possible to reclaim land from the sea. One windmill can bring the water only 1.5 mt, so some places one can see series of windmills to bring the water to higher level. Then steam engines came to boost the pumping stations. These developments brought us to the 20th century when we came up with the Delta project.
The land subsidence at places went as high as 5-6m in 1000 years. A land outside a church in the northern part is subsided 2.5 meters from 1646 till today. The Schiphol airport area is under 4.5m below sea level. It was a part of the lake called Haarlem-mermeer. But to get rid of the threats of inundation of the city Amsterdam, we had to reclaim land from this lake. Schiphol means ship's hails. In the former time, many ships used to anchor in this place, where there is now the airport.
Due to land subsidence, there was an intrusion of salt water and brackish water from below these polders and reclaimed lands. In such cases, river water was used to regain the freshwater regime and wash out the salted water. Water of river Rhine was used for that, but in effect the river's water become saline. Moreover, to make land more suitable for agriculture we started making dikes along the boundary between the rivers and the polders. Now, the sedimentation was restricted only between the dikes and hence there was a lowering of the riverbed. But there was subsidence on the other side of the dikes, i.e. on the polder lands. So there is a level difference between the floodplains and the polder lands. 7 years before there was river flood and the dikes were on the verge of collapse. The bad management of the dikes caused dike bursts.
But after the revolution of 1798, the central government came into being and a national organization was formed that managed the water problems of the whole nation. The governance system works in three levels, national government on the top under which there are the provincial governments and the third level consisted of water boards and municipalities. Water boards are very competent technically and they have their own financial resources.

So, the water not only affected the physical aspects of the country, it also changed the institutional parts of it. But large number of small water boards in past had limited governing power and less technical knowledge. Today, the situation is changed and the water boards are taking care of all the water systems in the country except the sewerage systems, which are in control of the local municipalities.
In the river systems we made many interventions including both making short cuts, new mouth opening as well as separating the river channels at places. The opening of new mouths by shortcutting was carried out in river Rhine, so that more water can go through the northern channels (earlier it was only 10% of the total discharge).

Interventions were not only concentrated in the river systems but there were big projects to protect the areas near the sea. 70 years before there was open sea connection for the inland sea on the western side and in the southern side, there were open sea connections to the river mouths. The storm surges as well as the intrusion of salt water were the main causes of concern. The areas in between were of high vulnerability to both storm surges and saline water intrusion. Hence, first the inland sea, Zuiderzee was closed, keeping in mind three broad purposes to be served, namely, to protect the hinterland from storm surges, to get a freshwater reservoir by transforming the inland sea to a freshwater lake and eventually to reclaim lands (polders) at different parts of this enclosed lake. Secondly, the Delta Project was taken up to protect the southwestern part of the country, i.e. the delta region. In the afternoon, we will see the Haarvig sluices and the storm surge barrier in the Rotterdam area. Originally there was no storm surge barrier in the Rotterdam area, but the development of harbor needed to deepen the river for better navigation of the ships to the harbor. At that time the storm surge, effects of wind etc. were not taken into consideration during the designing of the dikes in this area. The laboratory measurements couldn't take these aspects in consideration. A later mathematical modeling including the additional wind influence on this area reported that the design level of the dikes in the Rotterdam area is 60 cm low. So the dikes have to be increased to another one and half meter, which was impossible. The alternative approach was to build a storm surge barrier. There are other problems like environmental effects, nature conservation, the space to store water while thinking of the new constructions, the organization and cooperation between the different levels of the governance have to be considered. Moreover, another most important issue is the total time required. Time that takes to make some constructions and also keeping in mind the average land subsidence and the sea level rise, we have to plan the reconstruction of any structure, say dikes or storm surge barrier (100 years are estimated for this structure of storm surge barrier). Storm surge barriers are now closed at a rate of once in ten years but with increased sea level after 50 years we might have to close it more frequently, say once in a year or two years, but still it is profitable against the construction of dikes.
I would rather suggest this kind of structures in your country also.

Question: What are the main causes of the land subsidence in Holland? Whether building big structures in effect add to the causes of land subsidence.
Answer: The water extraction and lowering of the water table caused the oxidation of the upper peat layers. Dry peat are good fuel so peat were excavated. In the last century the pumping of water from the peaty land made it dry again. So the ways taken in former times were not very sustainable. In next 50 years some places, we expect land subsidence in the range of 60 cm. This particular place in the neighborhood of Delft University the difference already of land and sea will be 5 m both due to sea level rise and the land subsidence. From that you can understand what kind of protection measures we have to take. We have different flood protection standards are different in different parts of the country. The western part, the densely populated part have problems of storm surge and saline water intrusion, high tides have a high protection standard than the eastern part.

Question: What is the average thickness of peat?
Answer: It is variable as some places we have already compressed peat as discussed earlier. An initial 5 m thick peat layer is now compressed to a level of 2 m.
Question: Do you have discussion and cooperation with the upstream countries about the changed rainfall pattern and different sediment loads that the rivers bring from the neighboring countries? This is particularly a problem in the delta region.
Answer: Yes, we used to discuss with the upstream countries about the common interests, like shipping navigation and fisheries. The dams (450 along the whole river) along the river Rhine restricted the free migration of fishes like salmon and the increased navigation added to the problem. There were problems of pollutants that affect the mortality of the seals and in turn affecting the other sea products. It was not possible to use Rhine water for drinking. We have settled all these problems. The Rhine water is purified after the recommendation of the International Rhine Commission. Also we started ecological restoration of the river, as there were a lot of morphological changes due to interventions. So we cooperate each other to restore the water quality and the measures against flood. Now, there is a mental climate change among the people and the nations that they have to cooperate and help each other as all the problems are related and affecting everyone. Along the Rhine, there are now some retention areas near the Dutch-German border and in the German lands, for which we are paying because we will have profit out of these works. So the cooperation is very much there.

"Resilience strategies for flood risk management"

Ms. Karin de Brujin (Ph.D. student of Delft University)

Two main rivers, the Rhine and Meuse are the international rivers passed through the Dutch territory and almost two third of the country is under the risk of flood. So one can easily understand why in this country an intensive flood risk management

is necessary. As you know, we have different dike safety standards depending on the different parts of the country, starting from 1/10,000 years near the seacoast to 1/1250 years in the areas threatened by the rivers. And all these safety standards are calculated on the basis of the design discharge. But irrespective of the nature of the land-use (agriculture, urban, recreational and so on), the whole area in the eastern part of the country threatened by the rivers have a single safety standard, which is somewhat strange situation. The areas where both the rivers and sea have influences the safety standard level is in between, 1/2,000 years. In a typical Dutch river, no more natural setup is observed now, have the main course, a floodplain separated by embankment from the main stream and outside that there are higher embankment to protect the places where people live. The main stream has groins to control the sedimentation process and keep the depth of the inner part used for navigation of ships. The floodplains are dry in summer but almost every year they are flooded during the peak water level in winter. At summer these floodplains are sometimes used for recreational purposes. Floodplains are owned by the farmers and there are regulations on the use of it. Due to this typical morphology of the Dutch rivers, we either have no flood or have catastrophic floods. There is no chance of medium scale flood in these rivers. Recently, there were floods in 1993 and near-flood situation in 1995. There was a regional flood in 1998. As the safety standard of all the places are same, they didn't know exactly where the dikes would be burst during the 1995 flood as the Meuse and the Rhine water went up to the embankment level, the government had to evacuate 250,000 people spending a lot of money. After 1995 flood, the design discharge had been raised from 15,000m^3/s to 16,000m^3/s. The calculation of design discharge depend on the measured data of maximum discharge for 100 years and the data are extrapolated to make a safety level of 1/1250 years. So there is large extrapolation and hence, with the two peak discharges during 1993 and 1995, the design discharge changed sharply with an increase of 1000m^3/s. Moreover, there are risks due to climatic changes that are expected in coming years. Something has to be done to take care of this issue. The people now have more attention for the nature, land scenery, big structures are not considered nice anymore. The values in people have changed, they don't accept the disasters as they don't blame the nature or God but to the government as the government says always that the country is safe. So the disadvantages of the present flood risk management are that we don't know what will happen if the discharge exceeds the design discharge and as all the places have same safety standard it is difficult to forecast which area will be flooded. The risks and uncertainties are very high. The standard of 1/1250 years is on a design discharge of 16,000m^3/s whereas it was actually found to be in between 13,000 to 18,000m^3/s. Climatic changes are another source of uncertainties. The dike's stability is not known for the dikes everywhere as many of the dikes are very old. With more and more people start to live and industries etc develop with a fixed safety level, potential damages increase continuously. We have started to study five points on the river Rhine where the dike breaches are possible during high discharge and try to test the present risk management system in the country. The present study is on a resilience strategy. The idea is that you have a resistance against flood or any natural disaster as well and still you can suffer the damage. But if you can recover the damage by some process then it is called resilience in the system. Sustainability is a function of resilience and resistance. The flood risk management systems should be approached with both the river and the surrounding area in mind. Normally the flood risk management of the rivers takes care of a stretch of the river and the dikes only but not on the area and people around it. But in a well-planned FRM (Flood Risk Management) system, if the system responses by resilience and resistance, it would be a better system. So, resilience is the easiness with which a system recovers after a reaction on a disturbance and resistance is the ability of a system to cope with the disturbances by not reacting at all. Hence, resilience in FRM is the easiness with which the system consisting in the society in the area threatened by floods and the river system itself recover from flooding of a part of the area by a peak discharge. Resilience has to do with the damage also. In Holland, at the low discharge probability no damage is done until a certain discharge value reaches, and once it is reached the damage increases suddenly to a high level. In a resilient system this sudden jump of the damage is not there, rather a smooth increase of damage is viewed with increasing the discharge. So the new things about the resilient strategies are that it doesn't essentially prevent the floods but minimizing the impacts of the peak discharges.
It is considering not a small area (like where cities are situated or where agriculture is more concentrated) but a larger stretch of the river. The research on coping with flood risks is of two types where short-term measures are taken care of (design discharge and room for river). On the other hand, longer-term systems include emergency detention areas, bypasses (green rivers) compartmentalization, discharge distribution over the branches, research on the system behavior, resilience and resistance. But it is not yet known whether resilience is a solution, but it is worthwhile to study this so that at least we can know which direction we should think.

Question: Is there any insurance system against the flood?
Answer: No, there is no as such insurance system. There are small insurance companies and they were not in a position to introduce insurance system in case of high damages. They would be bankrupt. Though the safety levels of the dikes are 1 in 1250 years, the dikes have many weak zones and spots, so they are very vulnerable to dike breaches. One German company did survey and calculated the risk factors. They found it rather risky. There are cases of near misses, like that one occurred in the year of 1953, when a part of the dike along one of the rivers near Rotterdam was collapsed and we could put a ship in that hole and helped the situation, otherwise the whole area starting from the Rotterdam to Amsterdam would have been flooded. The problem is that some of the big urban areas like Rotterdam are in the deepest parts of the polders in the country. So this is rather dangerous situation. If there are substantial damages then there is some compensation from the national government but before that it had to be recognized in the national level. During the heavy rainfall in 1998, the roads in the Delft area were inundated. It is not a big problem for the people except those who are growing the products in glasshouses, greenhouses. Many products that they had to keep on the floor were damaged. 100 mm/hour rainfall is really a problem in this area.

In Italy, we traveled on road from Milan to Venice along the Po river and visited the Po delta area via Mantova. Near the delta at Porto Viro, the water in the river channel was flowing well above the surrounding ground level. We moved from there to north to reach Venice.

"Measures for the protection of Venice and its lagoon"   11th October 2002

Dr. Giovannni Cecconi

The representative of a private organization that is carrying out a project of the Ministry of Infrastructure on the Venice lagoon.

The lagoon of Venice is 50 m long and 10 m wide lagoon with inlets of water at places like Lido, Malamokko and Chioggia. Tidal range is one meter in the spring time. One meter in the tidal flat and 15 meters in the main entrances and 2 meters in the channels. The human intervention historically in many parts of this lagoon changed the morphology. It is an artificial lagoon in fact. The river that was meeting just next to the Venice area was stopped in 14th century, the jetty made near the Lido inlet and the littoral circulation made dikes and places of erosion, during 1970's the port that was started near Margerra, dredging of the industrial canal near it. Oil crisis during the 70's the work for port was stopped and now it is an environment resource area that intersects zones of tidal flat to salt marshes to inter-tidal zones and freshwater wetland and there are many species of plants and animals inhabit there.

A traverse from the mainland to the sea, we have the agricultural land one meter below the sea level with pumping stations to drain water from the land to a river next to it that has the capacity of $10m^3/s$ of discharge. Then one can see the freshwater wetlands to the brackish lakes to salt marshes to island with fish farming. Next to this is the historical place Murano that is adjacent to the barrier island, the littoral. There are extensive fish farming in this littoral. This is the overall transect of the lagoon. In the past there were many barriers without any regulation on the tidal inlets. But the Venezians started in the 14th century to cut the river and take them out of the lagoon. At the end of this process there are many examples of relocation of river outlets. Even the main Italian river Po was relocated 80 Km further south by making a diversion at Porto Viro. The Venezians were afraid of siltation problems for their ports and the stagnant water body that might cause some diseases. This changed the sedimentation process in the lagoon area. Many problems occurred due to this reduced sediment budget in the lagoon.

Morphologically, deepening of the lagoon and siltation of the canals had been started after these human interventions. Now, of about 2200 million cubic meter of the mud from the tidal flat, half goes to the sea and the other half are deposited in the channels to reduce their depths. To counteract this situation in the last 15 years we are making artificial salt marshes using the dredged material, 600 hectare of new wetland. Though it was tried to restore the wetlands by morphological restoration, there are, at the same time problems of land subsidence and sea level rises in addition of the lack of sediments from the rivers. In some of the eroding salt marshes, to keep the system from total submergence, there should be an accretion of one centimeter per year. To fight against this, we make artificial confinements and bring dredged material to restore the wetland area. Such kinds of restoration process for artificial wetlands are in numbers now. So one of the main activities around the Venice area is to protect the wetland and natural environment from erosion. There are also examples of erosion of the land by the waves produced by the navigating boats. Near industrial port area of Margerra, a channel was dredged through the reclamation area. There was a stagnation of water in this area, the new channel flushed out the sediments to open the water body and with the sediments some new wetland reconstructions here and there. This is very important, as there was lack of sediment and relative sea level rise.

In the last century, flood and its control in this area are also interesting. In the 1966 flooding, the San Marco square was under one meter of water and there were waves through the city. There are many frequent storms smaller than that of 1966 but with problems of the everyday living and the problems of pulsing effect of waves against the brick walls. Due to the relative sea level rise, the flooding increased in the last century about 8 times. Venice was flooded 5 times a year, but now it is flooded 40-50 flooding events in a year. In 1986, we had 100 flooding. There is a big jump of the number of floods around 50's. This was due to subsidence, both by the natural processes and man-made subsidence. In 1950s' there were the peak amount of man-induced subsidence. The land level at San Marco square is just 30 cm above the high spring tide, whereas, at the Adriatic sea the sea level rise was 11 cm, 4 cm was from the natural geological subsidence and there was some amount of subsidence due to human interventions. But now, we have reduced the causes of anthropological subsidence, so Venice is no more subsiding, only the problem is the geological subsidence with the sea level rise related to eustasy. In the island of Murano, the elevation of land is 100cm from the historical datum and the spring tide rises 70 cm that means there is only 30 cm elevation. In this situation if there is a storm or high water it will be flooded.

The solution to protect Venice against flood is that local protection till the elevation of 100 cm and then the closure the inlets by the mobile barriers, called the floodgates. These floodgates operate freely against the hinge that is fixed on the foundation of concrete casing as those are adopted for underwater tunnels. When there is high water level, the compressed air is injected into the floodgate casing and so that it can rise and separate the lagoon from the sea. The system is such that it can maintain a difference of 2 meters between the water levels on the both sides. When the water level in the sea goes down, water is pumped into the floodgate casing and so it can go back and rested on the foundation. This kind of mobile barrier is unique in the world. The metals are specially painted with chemicals to prevent the corrosion. Every 5 years we have to test the floodgate casing and changed. We have 80 barriers that means every month we have to maintain one floodgate. In respect to other barriers in the world, our barrier is different, like the Thames barrier, they have intermediate piers and they can take the gates in upper level and maintain. But due to the piers there are problems of environmental changes along the river. But for us, we were not

allowed to put piers.
The floodgates has to be closed 7 times a year at present, with 20 cm of sea level rise this has to be done around 60 times a year for a duration of 3-4 hours not more than that.
There are the problems related to the protection of the barrier islands of this lagoon. In 1966, there was erosion of the barrier island at Pellestrina and the city had to be evacuated to further way. There was an erosion of beach along the Lido littoral. The problem started because of the lack of sediment in the barrier island outer part of the lagoon. The length of the beach on the barrier is 60 km. We made artificial beach and widening of the beach i.e. beach restoration. We put 7 million cubic meter of sand from the sea at a depth of 20 m from a place, which was a littoral 5000 years ago. There was perched beach with small narrow groins. We took off those smaller groins and in place constructed large and wider groins with interconnected berms. Then sand was dredged from the offshore areas and brought into the places between the groins. So the new beach is added to the old one. To resist the wind driven sand drift the fences were put along the beach. In Pallestrina, and Cavallino, the "morphilla littoralis" was made by transplant different grasses and other plants. The artificial sand dunes with plants were found to be useful at the Cavellino beach. Reinforcement of jetties those were made in 1940 was another important intervention to make efficient groin system to support the jetties.

Question: What is the presence status of subsidence of Venice city?
Answer: Venice stopped sinking any more after we stopped extracting water from the underground. The subsidence was mainly due to that. Now, there is nothing but the relative sea level.

Question: With the sea level rise, what is the effect of the sedimentation in the lagoonal area?
Answer: The canals are affected by the sea waves due to level rise. The tidal flats are eroded and the sediments are driven to the canals and the artificial canals. There is siltation problem in the canals also.

Question: What is the drinking water supply for the city?
Answer: Now the water is taken from the mountain region by aquaduct, dolomites karst region with lot of drinking water supply is only 80 km away from the city of Venice.

Question: How long the city of Venice can be saved from total submergence?
Answer: The city of Venice was destroyed in ancient times and rebuilt. The civilization started in Venice 2000 years ago. Now the pavements are under 3 m of water, this means a siltation of 15 cm per century. The organic soil and the compaction of it caused to subsidence. At present, we want to save the city, conserve this long historical place. For that we think that the barrier has to be developed on the boundary of the sea. Without loosing any further land and monuments, we have to think of solutions, may be some new technology in the coming years.

Question: How many of the inhabitant of Venice is in favor of this kind of projects and plans?
Answer: 60% of the citizens are in favor, but 40% are against it. It again depend on what work you are in. If you are a shop owner who is affected everyday by the floods, they need the government to do something. This is a direct economic impact. There are indirect impacts. International pressure is there to do something to save the city. The city needs maintenance. But the people who are in the tourism business they don't want any maintenance work that take time as that directly harm their everyday business.

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