ITCOLD
Comitato Nazionale Italiano Grandi Dighe

VENICE AND FLORENCE
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A COMPLEX DIALOGUE WITH WATER
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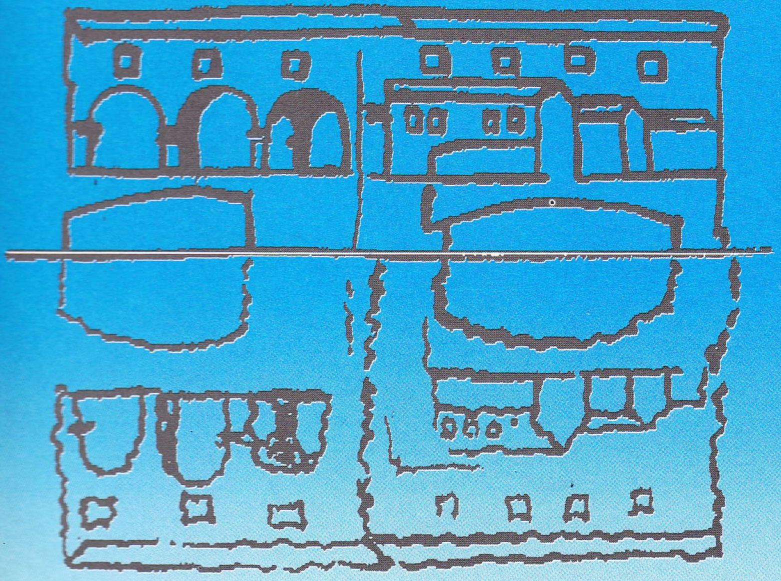

2nd Volume

24 Maggio 1997

Sala delle Nazioni — Fortezza Da Basso
Firenze

ITCOLD
Comitato Nazionale Italiano Grandi Dighe

Symposium

VENICE AND FLORENCE: A COMPLEX DIALOGUE WITH WATER

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First session

VENICE

INTRODUCTION

Claudio Datei

Istituto di Idraulica "G. Poleni", Università, Via Loredan, 20, Padova

I want to thank Engineer Dolcetta for his introduction, and also the Italian Big Dams Committee for having brought to the attention of our foreign colleagues the hydraulic problems for the protection of two big cities which are dear to us: Venice this morning and Florence in the afternoon. On behalf of my colleagues, I also want to welcome the participants and thank them for their help in dealing with the problems we are getting ready to examine.

Now I will give you a brief introduction to the problems of Venice, leaving to my colleagues a more specific treatment of the issues. As you all know, the problems of Venice are age-old and stem from a settlement which traditionally dates back to the year 900 in a lagoon area constantly connected to the sea and its inflowing streams.

Thus, the problems of Venice have a long history. In the year 1500, the great water technician, Cristoforo Sabadino, maintained that Venice had essentially three enemies: rivers, the sea, and men: rivers, because, bringing to the lagoon material and rubbish when they flooded, they contributed to raising its level, therefore, causing it to disappear. The sea, because with tides and storms, it contrasted and therefore brought about the destruction of many projects. Men, because of their not always proper interventions in safeguarding the lagoon.

Now I would like to say a few words in defense of men. Had it not been for men, Venice wouldn't exist at all; without those of the 1700's, the "murazzi" would never have been built. "Murazzi" is that first dam between the city and the sea which runs from Lido towards Malamocco and Chioggia. It offered extraordinary protection from high tides and storms.

So still today, we are indebted to men for this city's protection. Naturally, it has evolved in the course of time.

In the year 1700, Venice was connected to the sea by 7 not very large outlets which served for the naval, commercial, and mercantile activities of the population.

It is a well-known fact that the idea of making it into one big port in a modern perspective was Napoleon's. During his French dominion, in 1806, he had the first dam planned, the northern protection dyke.

After the events concerning Napoleon, whose memory Venetians are not fond of, the Venetians became famous, because of what they called the "Napoleonic trade-off" in 1797: an agreement between Austria and France to the damage of Venice, who was not even consulted in the matter.

In 1815 French dominion came to an end and the Austrians, the Royal Imperial Government, took charge of Venice beginning plans to build the dykes. Napoleon's idea had been to make a great military port, for which he had taken Malamocco.

The three large dykes were built within a century. The first gate is that of Malamocco, about 500 meters wide. It was later planned with empirical but solid criteria, based on the experience of the Lido outlet, 900 meters wide, and last, the Chioggia outlet, a few hundred meters wide, which was completed after the end of the first World War.

In just a short time, the canals limited to the dykeswere deepened and allowed the port and mercantile activity to begin. That same activity still continues today. Naturally, more complex activity was projected, potentially more dangerous than what was carried on in the past: let it suffice to mention the petroleum trade.

In modern times, the problem of Venice arises particularly after the event of 1966; an enormous flood wave put the city under high tide, aided by wind at +1.93. It was later calculated that on the average, such an episode could be expected again no sooner than 200 years. Previously, the biggest and most important tidal event dated back to the last century, I believe in 1867, at 1.57. We must keep in mind that Venice today is lower than the average sea level by 23 centimeters, I believe; partially due to phenomenon of subsidence or settlement, because Venice is a heavy city on not very solid ground, and partially to the average increase of sea level.

Under these conditions, the occurrences of so-called "high water" of Venice have gone from 6 or 7 times a year at the beginning of the century to a current average of 42 times. Some places like San Marco Square, for instance, and the Basilica with its low vestibule, have "high water" for an average of 200 times a year.

In 1978, therefore, the problem of protection, of safeguarding Venice and its conservation arose dramatically starting from 1966. It is however true that the Venetian experts, the Venetian Institute, and the Venetian Magistrate of Water, an ancient institution, have always been concerned about the poblems of Venice, but it took a clamorous event like the 1966 flood to call the attention of politicians to the situation. This came about with two fundamental, but naturally not immediately effective, laws. One was passed in 1984 and allowed the realisation of a consortium of contractors and planners who have systematically taken on the city's problems.

But Venice's problems are much more complex than they seem because it is a far more complex society than the one of past centuries, and therfore, along with the protection of the city from high water, all the activities that make Venice and its hinterland an active and living structure must be preserved.

Therefore the port activity and all that is relative, with the addition of a big territory of 1800 square kilometers, burdens Venice, draining its water into the city. The territory is flat, with important and profitable agricultural and industrial activities, but also with waters whose quality is dangerous for the preservation of Venice. Thus there is a problematic, and considerably complex relationship between the sea and the lagoon and hinterland.

If on one hand, a serious situation unites, administration divides. Water goes from the hinterland through the lagoon towards the sea, returning with the tide. The Regional authorities are responsible for the draining territory; the local administration is responsible for the city, and the State is responsibile for other activities.

It must, however, be said, that a common intention and planning around these aspects has been realised, and many projects have been carried out because the main, fundamental problem has become that of maintaining the existence of Venice as a living city and not a museum. Therefore, there is the desire to maintain all the activities. The idea, for example, of closing the gates, is the only way of controlling the tides above a certain level where this comes about as often as it happens in Venice today. This, however, would determine a closed regime, and a prolonged shut-down that might damage the activities and also the quality of the water for the exchanges between sea and lagoon.

To this regard, there is a highly intelligent plan to divide the tide up to a certain level, check it with works of bordering and uplifting without dividing the gates up to a certain level, and above that level provide, when the gates are built, for its shut-down. In this way, on the average, the openings are shut 7 or 8 times a year, naturally if the sea level stays as it currently is. Geophysicists are not certain of the future: prospects of average uplifting of sea level are pessimistic. Let it suffice to think that if the average sea level or the relative difference of level between Venice and the sea increased by 30 centimeters, there would be "high water" every day in Venice, and therefore every day it would be necessary to shut the gates.

The prospect is therefore unsettling, but should sea level rise to such an extent, the problem would have to be seen on a planetary scale, no longer restricted to Venice alone.

Unfortunately, the lowest point of Venice is San Marco Square, "the Jewel", which characterises this city. A plan has been drawn up and approved on a preliminary basis for an intervention that would raise the entire floor of Venice with subsidiary works, also for water control, protection from precipitation or whatever other source there might be.

The plan of the big gates was approved by the High Council of Public Projects with an epic battle because unanimous acceptance is non-existent among Italians from different political backgrounds and cultures. The plan was approved some yers ago, but we are still waiting to move on the the executional phase, and the evaluation of the environmentalmental impact of the gates is being defined.

An International Commission has been studying and has concluded this work, which will be presented to the Ministry of the Environment for evaluation. This is one sort of causes of delay in the passage from the preliminary planning stage to that of executional planning.

Naurally, the executional planning will not be able to take less than 3 or 4 years, and for the building stage, I think I am being optimistic to expect a period of 10 years, but many problems are connected to the succession of the projects, such as whether to take them on in parallel, all three at one, or work separately, gate by gate, spreading them out in time.

These are the problems that I believe await future generations. My generation had the task of laying them out and taking them on.

Venice has always been an object of study for Venetians and Venetian water technicians, with their professional knowledge, intelligence, observation, and experimentation, so the empirical groundwork of science, the first step was theirs, but 90% of what is knows about the Lagoon we have learned in the last15 years, through the work of my generation, and we are proud of this.

Jack Lewin

Consultant Professor, Richmond (UK)

The definitive design of the movable barriers across the navigation openings from the Adriatic sea into Venice Lagoon was completed in 1992.

The design was developed following the successful demonstration of the principle of the buoyant gates in a prototype installation, the experimental module MOSE'.

The mechanical and electrical design of plant and machinery as well as the safety and reliability of the design was examined by an International Commission of Experts who endorsed it and commented very favourably. Their final meeting was on 3rd July 1992 The civil engineering aspects were scrutinised in detail by another International Commission.

The Magistrato alle Acque and the Ministry of Public Works approved the definitive design of the movable barriers in 1994.

An environmental impact study is only now being carried out, fine years after completion of the definitive design and the investigators are not due to report for some time, although the special Interministerial Commission order in 1995 that the study be carried out This is an undue delay.

Political objections and uninformed hostile comments have been reported in the Italian press. Technically invalid reasons have been cited in opposition to the movable barriers. There has been little authoritative support and statements in favour of the barriers. Italy should be proud of the technical excellence and effective solution which the scheme demonstrated.

In the Great Britain the rise in sea level has to be considered for all projects of sea defence work. The effect of increased height of storm surge levels has to be taken into account. The Environment Agency, a Government Body has commissioned consulting engineers to determine the work necessary for the Thames barrier and the other barriers on the Thames to withstand substantially higher flood levels and increased frequency of barrier closures.

On the Thames, the extrapolation of the number of barrier closures per years during the last 12 years is an indication of the seventy of the problem of flooding during the next century.

Engineers in the Netherlands are equally convinced that engineering solutions are necessary to withstand higher and more frequent storm surge levels.

The conditions in the Adriatic have some similarities with those in Britain, the Netherlands, Belgium and North Germany. The records of the last 10 years show a strong trend towards more frequent and higher storm surges.

To maintain that there will be no repeat of the 1996 flood is unrealistic.

This symposium is a preliminary to the 19th ICOLD Conference. A number of papers deal with reservoir safety. Probable maximum floods will be considered to which a 1 m 25000 years return period is conventionally assigned. Even the half PMF is of a much higher order than 1996 Venice flood, which can be classified as an 800 year return period flood. Other engineers have attributed different values to it, but this is not material. Extensive work is carried out in many parts of the world to improve reservoir flood release for at least the ½ PMF, yet in the case of Venice, the protection against an 800 year return period flood is questioned. Work during the last years in connection with the risk of flooding in the next century suggests that the return period of the 1966 flood must now be regarded as substantially lower.

It has been suggested that the definitive design for the flood barrages of Venice will not be adequate to withstand higher flood peaks than that of November 1966 and that higher flood levels must be expected.

The existing design can be scaled up to withstand higher flood peaks and a re-assessment of the level of protection is justified.

From hydraulic considerations there are no interim or alternative solutions to the barrages at the entries to the Venice Lagoon, except to turn it into an inland sea, which is contrary to the Law of Venice. The flood waters which could be absorbed by the barene is insignificant compare with the storm water which enters the Lagoon, even if the barene could be rehabilitated. Filling the dredged navigation channels within the Lagoon would result in some benefits but would not attenuate a flood.

The insulae scheme is a temporary and localised solution to low level flooding. The levee effect presents new dangers.

To reduce flooding to low levels, the navigation passages into the Lagoon would have to be narrowed to 5% of their present width, which is also contrary to the Law of Venice.

There has been little authoritative support and only few statements in favour of the barrages.

Is another 1966 flood and a few casualties necessary to silence the opposition to the barrages for the protection of the Venice Lagoon. Italy must protect this wonderful heritage which is at risk.

PHYSICAL MODELS CONCERNING THE DESIGN OF THE MOBILE TIDE CONTROL WORKS PLANNED FOR THE VENETIAN LAGOON

ATTILIO ADAMI

University of Padova

As the presentations of this morning have amply explained, the solution that has been selected for the barrier works at the Venetian lagoon inlets involves the use of *buoyant gates*. This particular type of gate offers various advantages and has the characteristic of being absolutely innovative, without precedent in works constructed to date. This originality has led to the need to do a considerable amount of theoretical and experimental research to obtain the information needed to support the project. It goes without saying that most of the applied research work focused on the behavior of the gates, both alone and in rows, under the effects of wave motion. Various studies were performed, starting from experiments in a channel with a few gates (one at the Estramed Center in Pomezia, another at the De Voorst laboratory in the Netherlands) and going on to investigations on the whole row (again in the Netherlands and subsequently at the Test Center in Voltabarozzo, just outside Padova).

All these studies have been documented in various scientific publications (Adami, 1995; Adami et al., 1995), but it is worth mentioning that the results obtained have given rise to some very interesting original research by Giovanni Seminara in Genova and by Chang Mei in Boston.

Here, it is probably more useful to briefly recall another three experimental studies on models that are certainly of less scientific interest in general terms, but have been extremely useful in the design process and have brought to light some interesting, though unoriginal, aspects concerning model-making methods.

The first of these experimental models had to do with the problem of how to install the foundation caissons for the works at the lagoon inlets. As already reported, the fixed part of the barrier works is made of concrete and comprises a set of caissons that are built afloat, then transported to the installation site and sunk onto the previously-consolidated foundation soil. The caissons must be placed side by side so that an underwater tunnel can run through them, housing all the utilities for operating the gates – hence the need to position the caissons with a considerable degree of accuracy. For this purpose, the plan is to rest the caissons when they are sunk on adjustable jacks, leaving a gap between the caisson and the foundation layer. The gap is subsequently sealed with cement mortar, once the jacks have correctly adjusted the position of the caisson. Clearly, it is a good idea to keep the caisson as light as possible throughout this operation, but it is also obvious that this phase may take some time. This poses the problem of how to establish the minimum weight to attribute to the caisson so that it can withstand the effects of wave motion in the event of a sea storm occurring while the caisson is in this condition.

A mathematical model was thought to present considerable uncertainties, so it was decided that a study on a physical model was needed. The model was prepared in Voltabarozzo, using a part of its model sea tank. A scale of 1:60 was used and the model caisson was made of methacrylate resin, with ballast distributed inside it in such a way as to maintain the position of its center of gravity.

The caisson was examined under the effect of a tidal stream and a polychromatic wave motion with an established wave energy spectrum, measuring the amount of additional ballast required to prevent any displacement of the caisson.

Without going into the details, that are probably of little interest here, it is worth mentioning that the model posed an interesting problem as regards the recording of the caisson's movements. In this case, it was important to be able to record the lack of motion, however slow and limited in amplitude, so the standard instruments proved unsuitable. After several attempts, a solution was found in the use of flexible elements (steel bars 10 cm long, 1 cm wide and 0.1 cm thick) fixed solidly to the caisson and positioned so that, when they were at rest, they brought a pressure to bear on loading cells distributed near the corners of the caisson and attached rigidly to the floor of the model. This meant that as the caisson lifted it caused a change in the pressure exerted on the sensors.

The second problem that emerged and is worth mentioning here concerns the replacement of a gate for maintenance purposes. The project caters for a platform equipped with winches and grappling beams to be provided on the gate. The gate is hooked up and, at the same time, the hinges that hold it in place are detached from the fixed foundation bed.

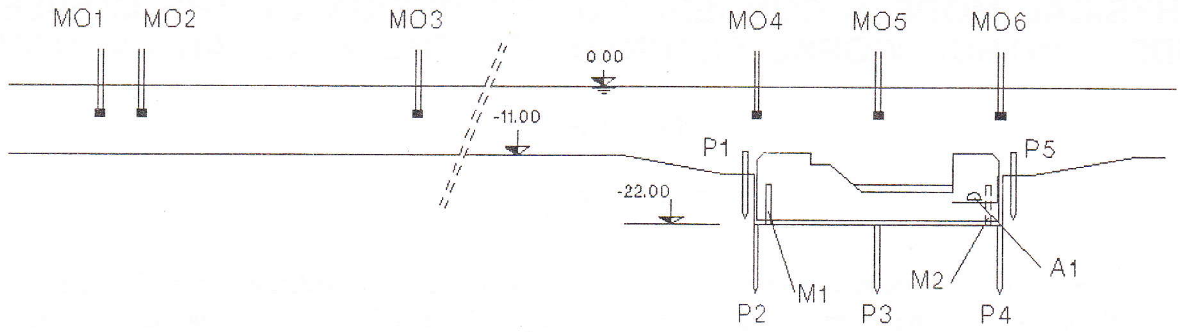


Fig. 1 - Arrangement of the foundation caisson for the gates in the model MO: wave motion recorder; P: pressure gauge; M: sensor for monitoring vertical displacement; A: accelerometer

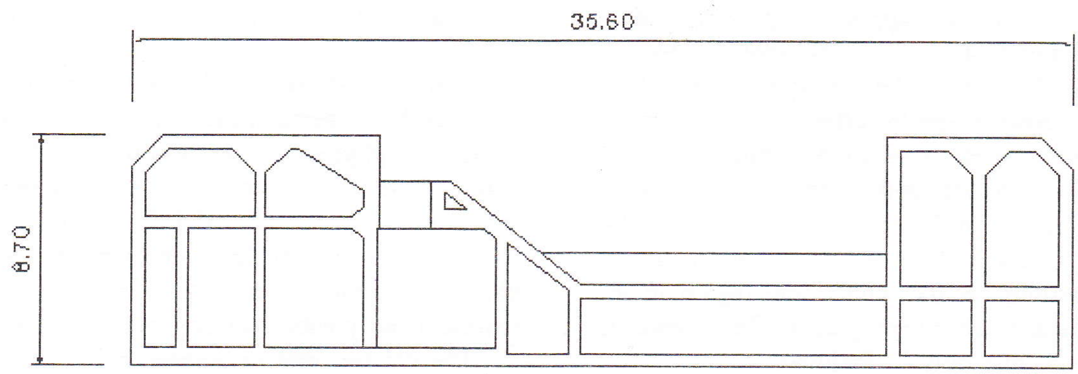


Fig. 2 - Typical cross section of the foundation caisson for the gates

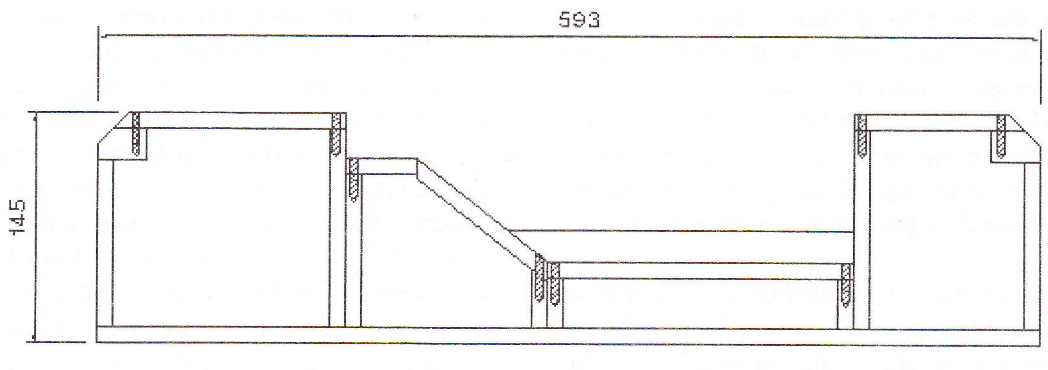


Fig. 3 - Typical cross section of the model foundation caisson for the gates

The problem to consider on the model consisted in how much wave motion was allowable for the gate raising operation to be able to take place normally, especially when the gate is partially above water. A scale of 1:30 was used for the model and the study was performed at the model sea tank at the Voltabarozzo Center.

The gate was placed horizontally in this case and was examined in different stages of immersion, under the simultaneous effect of a tidal stream and a wave motion with an established wave energy spectrum and a progressively growing intensity. The measurements that were taken consisted in pressure recordings on the walls of the gate and force

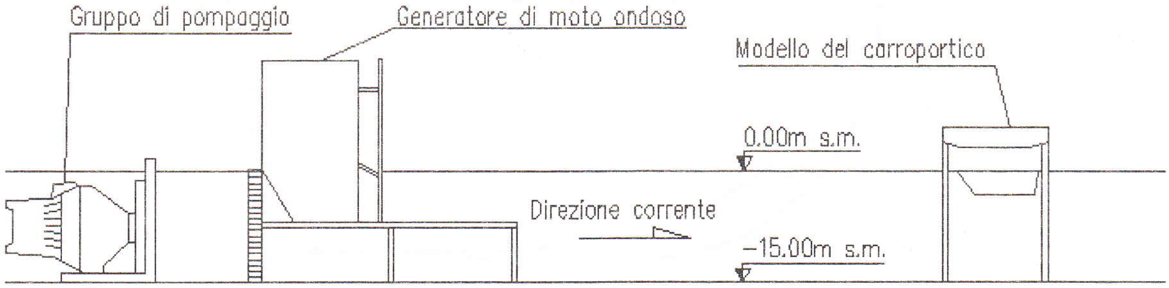


Fig. 4 - Diagram of the model gantry crane used for gate maintenance operations

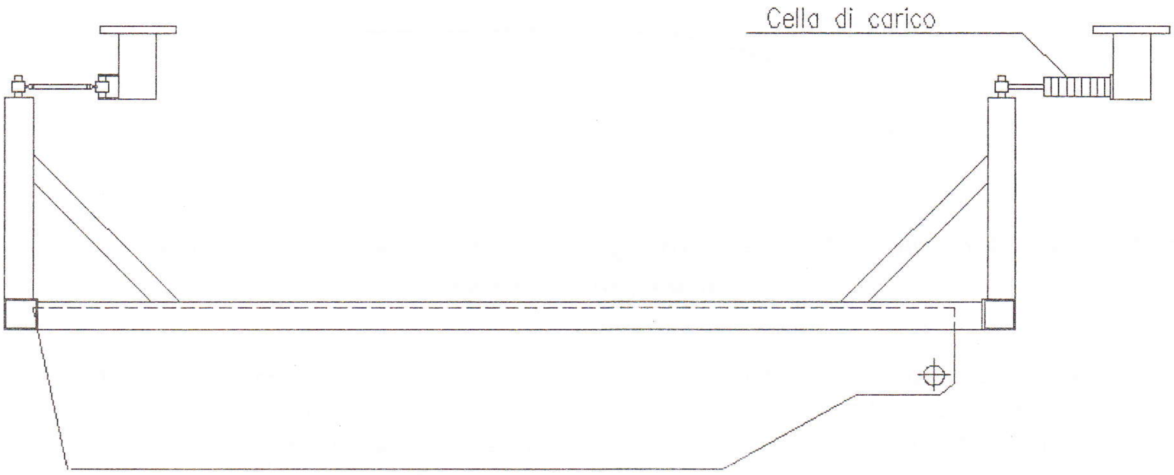


Fig. 5 - Diagram of the model gates and of the grappling beam

measurements, using dynamometers, on the restraint points of the structure.

Finally, the third study that I would like to mention involved the transients that develop in the vicinity of the works, both on the lagoon side and on the seaward side, during the closing of the inlets. It is important to bear in mind that any barrier closing operation must precede a peak high tide when this is higher than allowable, so it occurs in the presence of a tidal stream that may have a considerable speed, even in excess of one meter per second.

In these conditions, we have to deal with a phenomenon of translational waves (that are positive towards the sea and negative towards the lagoon) which could be examined by means of a mathematical model, but existing models for the lagoon as a whole have too large a spatial pitch to be able to represent these small-scale processes. The positive wave towards the sea was evaluated using a specifically-prepared one-dimensional model that enabled the gate closing time to be established as no less than thirty minutes.

There remained the need to examine the phenomenon on the lagoon side, however, since an excessive negative wave could prove dangerous for the stability of the lagoon channel banks – especially at the Lido Inlet, which is the most delicate and the most important in historical and artistic terms. Given the complex geometrical configuration of the field of motion, it was decided that this study should be performed using the physical models at the Voltabarozzo Center. The center has a general model of the whole Venetian lagoon (built in the seventies) and detailed models of its three inlets.

The general model occupies an area of about 12,000 square meters and provides a valid representation of the boundary conditions of the phenomenon; in particular, it allows for the correct reproduction of tidal streams using the generator with which it is equipped. On the other hand, this general model has the drawback of being badly distorted because it is on a planimetric scale of 1:250, whereas its altimetric scale is 1:20. The detailed models of the inlets are on a scale of 1:60 and are undistorted, but they have the disadvantage of operating in permanent motion. Moreover, the modest extent of lagoon area they reproduce prevents a correct

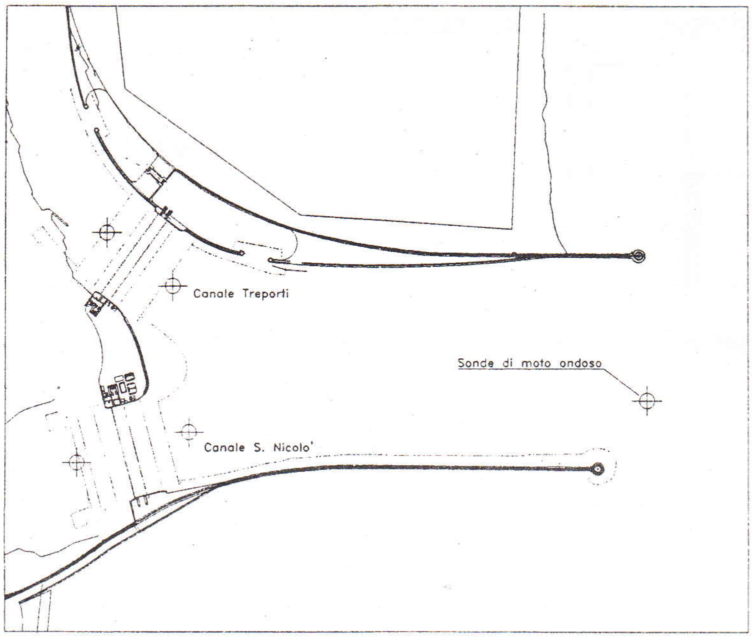


Fig. 6 - Layout of the Lido Inlet showing the positions where the levels were recorded during the experiment.

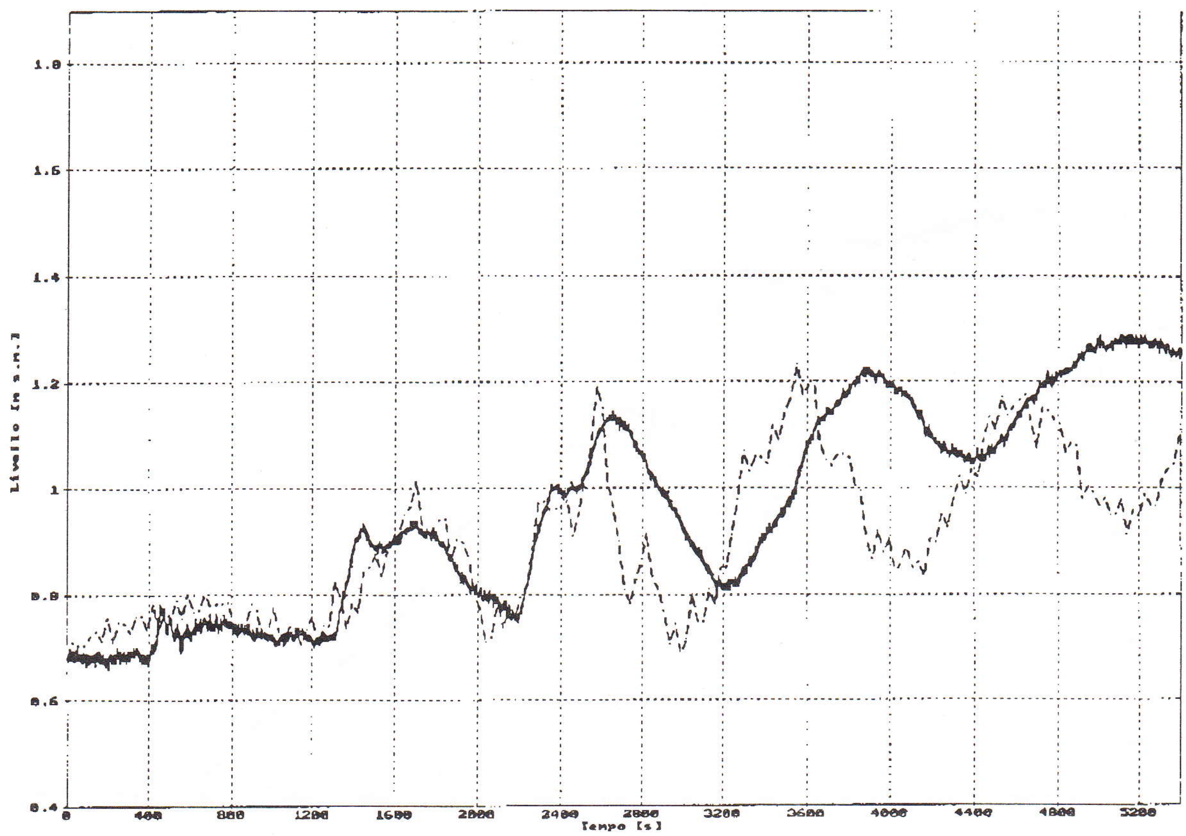
representation of the negative wave propagation in the channels. As a result of all these considerations, it was decided that the phenomenon in question should be examined for the Lido Inlet alone, using both the general and the detailed models in order to emphasize any scale effects, well aware that the comparison was only feasible for propagation towards the sea.

Without going into details here, I shall again restrict myself to mentioning the most interesting results from the model-making standpoint. First of all, the two models demonstrated a valid consistency as regards the maximum and minimum wave heights: the differences that were detected were expected, since they are immediately justified by the different surface roughness of the models due to their different scales. An unexpected finding, on the other hand, was the difference in the inlet channel's oscillation period, which proved considerably greater in the undistorted model. An explanation for this difference emerged from careful analysis of the phenomenon in the two cases.

In the general, distorted model, the inlet channel is narrow and deep, so the motion is almost perfectly one-dimensional, making the node of the wave's oscillation virtually coincide with the final section of the channel. In the undistorted, detailed model, on the other hand, the channel is much wider than it is deep, so the node of the wave's oscillation is found to lie along a very nearly semicircular line, with an increase in the mass involved in the process.

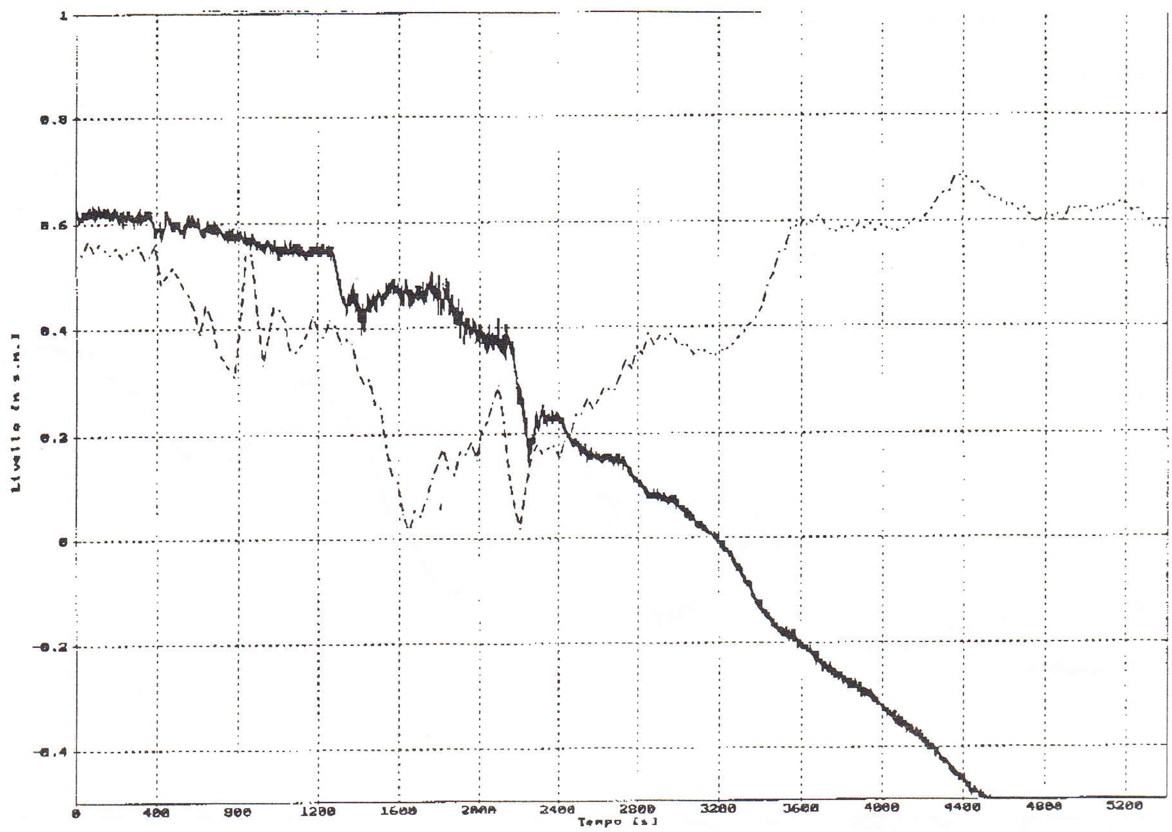
A final comment concerns the barrier at the Lido Inlet, which comprises two barriers that are expected to close proportionally and simultaneously. In the general model, it was found that a faulty closing operation could trigger, a persistent oscillation of the basin directly in front of the works that was transverse with respect to the main oscillation.

This secondary oscillation never occurred in the undistorted model, however, despite several attempts to trigger it. Very probably, this difference in behavior depends on the different shape of the basin, particularly in terms of the sloping angle of its banks, so in my opinion this is a case of an unexpected effect of the scales being distorted.



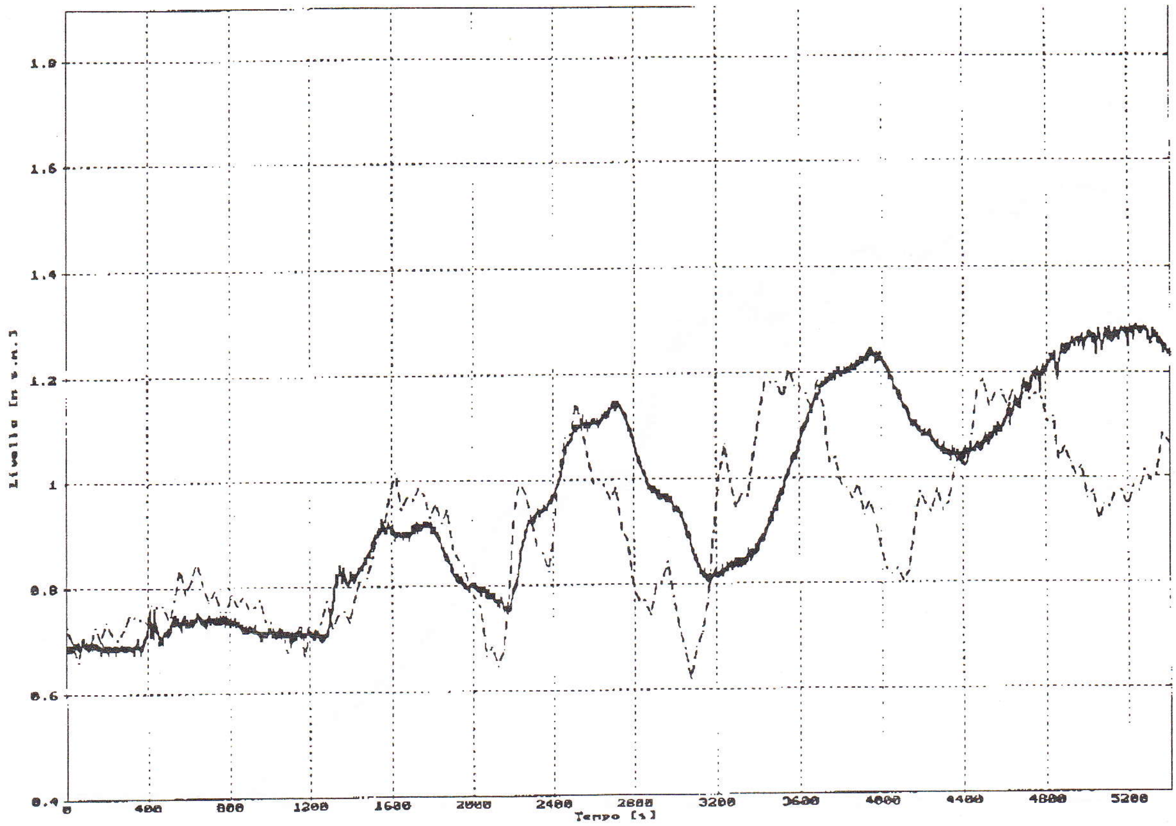
------- *model of the inlet (scale 1:60);* ----- *general model of the lagoon*

Fig. 7 - Height measurements during the simulated gate raising operation. San Nicolò channel, lagoon side.



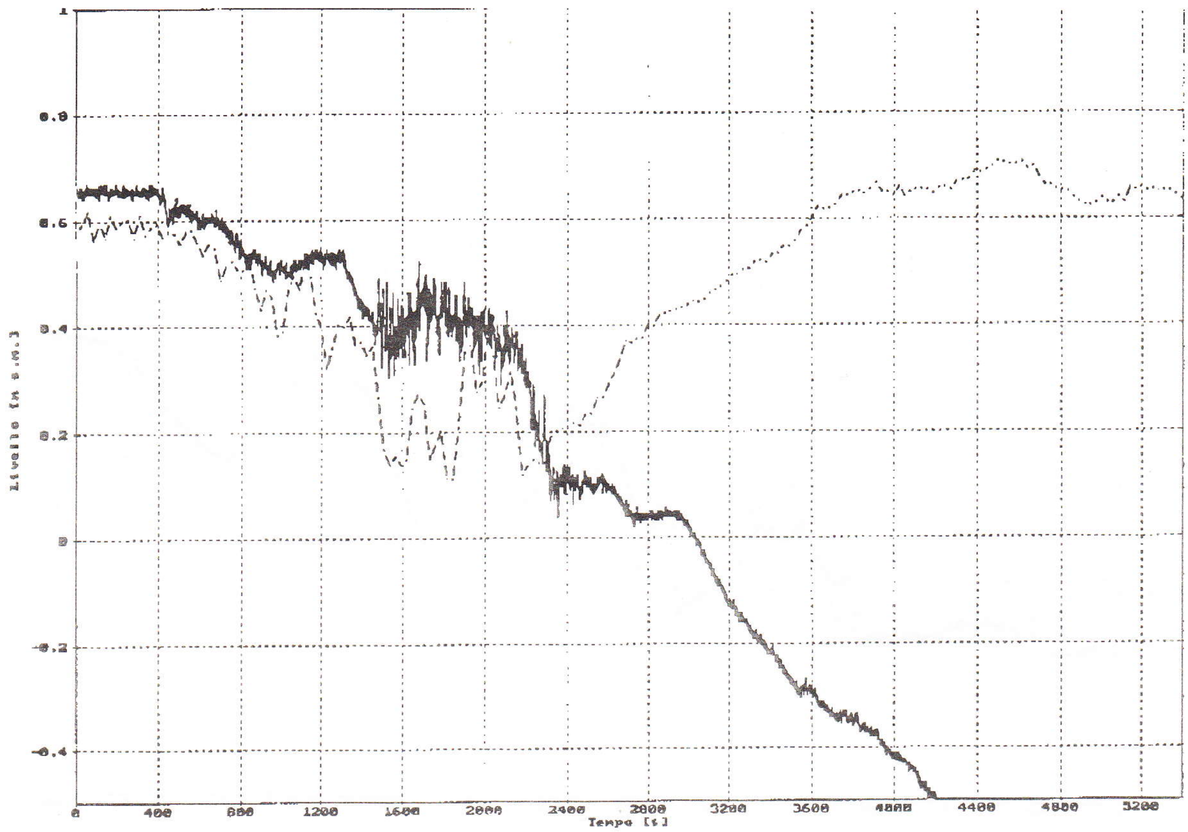
------ *model of the inlet (scale 1:60);* ----- *general model of the lagoon*

Fig. 8 - Height measurements during the simulated gate raising operation. San Nicolò channel, seaward side.



------- *model of the inlet (scale 1:60);* ----- *general model of the lagoon*

Fig. 9 - Height measurements during the simulated gate raising operation. Treporti channel, seaward side.



------- *model of the inlet (scale 1:60);* ----- *general model of the lagoon*

Fig. 10 - Height measurements during the simulated gate raising operation. Treporti channel, lagoon side.

CONCLUSIONS

CLAUDIO DATEI

Istituto di Idraulica "G. Poleni", Università, Via Loredan, 20, Padova

I want to thank Professor Lewin for this intervention and also for the recognition extended to the work our country has done on the problems of Venice.

I remember some important dates. The general plan was ended and presented to the Waters Magistrate and approved in 1992 and brought to Rome for evaluation by the highest State technical body: the Superior Council of Public Works. After a lengthy inspection, because also on that occasion, there was not unanimous agreement as to the efficacy of the proposed solutions, the plan was presented to the General Assembly of the highest State technical body and approved with some difficulty in October, 1994.

Regarding this project, there was also a pronouncement from the Venice City Administration; not a State technical body, but only the representation of positions and opinions coming from political parties. It is rightly a political viewpoint. There was is a deliberation on 15 March, 1995, requesting the evaluation of the environmental impact.

The Interministry Committee, presided over by the Prime Minister, naturally agreed to this request of evaluation of the possible environmental impact, in connection with the building work to be done on the outlets. But the Venice City Administration, armed with zeal perhaps worthy of different causes, added on many problems to examine, including that of zero options, or not doing anything, leaving things as they are with widespread interventions.

Naturally, as Professor Lewin observed earlier, re-working the boring bars within the Lagoon in order to rehabilitate old morphological structures does not at all modify the height of the tide that may involve the Lagoon.

All the same, with no small degree of misfortune, Mayor Cacciari of Venice stated last year that there was no longer any need for concern, and that many problems had been solved. I say "misfortune", because ten days of high tide in only a few days followed, with consequent great invasions of the Lagoon of Venice.

Unfortunately, my fight for the problems of Venice has been going on for 40 years, since I am a member of the Hydraulic Institute of the University of Padova, which is the Court Hydraulic. In fact, the president of the Waters Magistrate should know that since 1907, we should be receiving funds in the amount of £40,000, as written in the Magistrate's Statute. Not only have they not been revalued, but we don't receive these funds at all.

So this battle of the Venetian Water Technicians' Institute in favour of the Lagoon and the Waters Magistrate has always been going on. Our teachers before us were likewise involved.

But the Venetial hydraulic culture relative to tides and waves is not as widespread as it should be, and thus our representatives in the City Administrations make statements that, as Professor Gentilomo just ironically observed, would make Galileo Galilei, who taught in Padova, turn over in his grave. Professor Gentilomo spoke this morning about extravagant porposals, which are actually that: extravagant proposals. But wrong ideas are more successful than right ones.

No one, for example, has any idea as to the wavelength of the semi-diurnal tide. In the Lagoon, it is 150 kilometers, and as Professor Marchi observed this morning, the distance from Lido to Venice is just a few kilometers. It is impossible to imagine that there be any attenuation whatever; all the same, the widespread interventions, including the zero option, find approval with a certain part of public opinion, where there is no knowledge of the theorems.

So we can in this way explain the delays with which provisions are taken. It must, however, be said that the Venetian Waters Magistrate and the Ministry of Public Works function well and follow these problems with great attention, in spite of all the constraints that are represented by the appointments they must consider, such as that of the environmental impact.

The study on the environmental impact has come to a conclusion and we are now awaiting the opinion of the Commission named by the Ministry of the Environment. We hope that among the members of this Commission for the Environment there are also those who are knowledgeable regarding waves and environmental factors, in order for the ridiculous observations that have been promoted even in authoritative places to be disproven.

SECOND SESSION

FLORENCE

INTRODUCTION[1]

FRANCO BARBERI

Sottosegretario di Stato delegato alla Protezione Civile

Good evening, ladies and gentlemen. We are going to start the second part of this symposium devoted to two large artistic cities which have a serious and dramatic problem with their relationship to water. After the discussion on Venice this morning, the second part of this symposium will address the complex situation of the city of Florence. You will all recall that about thirty years ago, the city of Florence was dramatically affected by a major flood, with the destruction of a lot of properties, several human lives. It is unfortunate that a first remark that for several years, actually nothing was learnt by that lesson, and a rapid look at the present situation of the Arno Basin shows, as Professor Nardi will demonstrate, that the kind of intervention made in the Basin have dramatically increased the risk because of the progressive invasion of the area near the river by any kind of settlements and building. Only since very few years, with the constitution of what is called the National River Authority for the Arno River, which is governed by Professor Nardi, a systematic activity has been taken in order to address the general problem or risk assessment and risk reduction. As you can imagine, all the measure that have to be adopted in order to reduce the risk have a serious impact and a lot of implications on the way that this land has to be administrated in the future. So sometimes there is a high level also of polemics between scientists that indicate the kind of measures that have to be adopted in order to at least not farther increase the risk and, to the contrary, introduce measure for risk reduction and mitigation and a current attitude of using the land without any rational order. But nevertheless, substantial steps towards a correct managing of this Basin have been obtained.

During the presentation, I'm certain that we will have a complete presentation of the Arno problem. Professor Nardi will illustrate the general project of the Arno Basin, then we will have consideration of how this plan impacting has to be included in the general program of environmental politics in this field. And then many other relations will address specific problem related to the drainage of this area, use of existing dams, as for the lamination of floods and other specific aspects. As national reponsible for civic protection in Italy, we are obviously very strictly interested in the development of this new activity for urgency planning in risk reduction. In Florence as in Venice, we have started the systematic activity, including sewer perfection exercise, simulating the emergency that might occur, and also taking care, in addition to the current protection of population living in the risk area, also addressing the very delicate problem that exists both in Florence and in Venice, of the protection of the relevant arts, manufacts, from painting to statue to books that has to be protected as did not occur thirty years ago. So I can say that in this way it is an important activity in order to address the risk problem in this area from all point of view. And assessment of the risk, preparedness of plans, including obviously the very important risk reduction, risk prevention, engineering intervention has been at once addressed.

So I'm certain that this symposium will address all these aspects and there will be the opportunity of an interesting discussion. So I am now introducing the first general relation of the symposium by Professor Nardi, which will illustrate the general project for the Arno River, on which he has the main responsibility.

[1] The text has been edited by the Secretariat and has not been revised by the Author.

FLOOD MITIGATION DAMS

LUIS BERGA

Chairman of ICOLD Committee on Dams and Floods, E.T.S. Ingenieros de Caminos, Canales y Puertos, (School of Civil Engineers), Barcelona, Spain

Thank you, Mr. Chairman, Ladies and Gentlemen. I'd like to present some ideas, and facts about flood mitigation dams.

Floods constitute one of the natural disasters of most impact on the population, producing each year thousands of victims and enormous economic losses. The greatest natural disasters in the world show an increasing evolution as is deduced by the International Decade for Natural Disasters Reduction, which showed the number of the disasters in the period 1963 to 1992.

Within these natural disasters, the greater number correspond to floods, with 32% in relation to the significant damage and effect on people, and 26% in relation to the number of deaths.

Analysing the natural history of a flood, the measures to foresee and reduce the damage that it produces, can be classified in the following manners: A) structural actions, they are measures to interfere on the phenomena of formation and propagation of the floods. That's soil conservation and correction of basins, dams, flood control and regulating reservoirs, and hydraulic works the rivers: levees, dikes, diversions, channels improvements, etc.

B) Non-structural actions. They are measures to mitigate or reduce the damage produced by the floods: Risk maps, flood plains zoning, land use patterns, insurance systems, and welding legal regulations with general regulations.

Another type of non-structural measures are actions in order to foresee and thus reduce the damage produced by floods. That means flood forecasting and flood warning systems, and emergency action plans. Within these measures, reservoirs constitute a very efficient structural solution for the reduction of damage produced by the floods since they are the only element that can store water in a significant manner and so reduce the peak flow of the hydrograph. But for this, its effects should be studied in the whole of the basin.

Nevertheless, in order to reach a greater effectivity, it is necessary to study the possible combination and introduction of structural and non-structural solutions. Being necessary in many cases the development of zoning and land-use patterns downstream of the dam and also flood forecasting systems. Then, in each particular case, it's necessary to analyse and plan as regards the basin the various possible measures.

Usually, the reservoirs that have the main or single purpose of the lamination of floods are referred to as "Flood Control Reservoirs" – a denomination which induces one to think that they are able to control all the floods and therefore avoid any damage to the inhabitants and townships downstream. Evidently this is not possible and less still in the uncertain subject of floods in which the absolute zero risks cannot be attained with actual physical and technical knowledge. For this reason, it would be better to refer to flood mitigation reservoir or dams in the sense of indicating the capacity of these structural measures in the mitigation or reduction of the damage produced by the floods.

The hydrological criteria to be followed in the design of flood mitigation dams are fundamentally three:

1: Dam safety or hydrological safety of dams as usual with inflow design flood equal to the safety check flood as a condition of safety, and which for the high hazard dams is the PMF in the United States or high return periods in European countries of five thousand to ten thousand years.

2: The reduction of flood damages, usually as a protection for lesser floods of 50 to 100 years, or in the case of important cities downstream, up to 500 to 1000 years return period.

3: Overall view of the floods in the basin with the effects of the reduction of the flood peak and lag in times, in the flood routing, and its incident downstream with the presentation of the floods in tributaries or in other reservoirs..

In the studies of flood mitigation dams there arises on numerous occasions, the alternative of constructing a larger dam on the main river close to the area to be protected, or various small dams located on the headwaters or middle stretch of the basin and on the tributaries of the river.

Diverse examples, such as are the cases of the Miami District, or the protection of Girona on the River Oñar in Spain, show that technically a greater protection is obtained with large reservoirs situated upstream of the area where the flood damages have to be mitigated, but on numerous occasions the economic, social and environmental aspects present a problem for the construction of dams in the immediate area upstream of the townships to be protected.

It must also be taken into account that in many countries of the world large populations and important cities have been established over the years on the rivers plains which form the backbone of the country with which the application of some of the non-structural measures is non-viable (resettlement, land-use patterns, etc.), and the only possible action is to reduce the frequency of the constant and repeated floods, a role that can be carried out by the Flood Mitigation Dams, which although not with a total protection (25 to 100 years), reduce in a very significant manner the grave impacts due to almost annual" floods.

In Spain floods represent the most important natural hazard of the country and that of most impact on the historical memory of its inhabitants. For this, during the last decades, diverse structural and non-structural measures have been introduced, among which it is possible to point out the construction of Flood Mitigation Dams. So, in the year 1991 there were 11 flood mitigation reservoirs, which represented 1.2% of the existing reservoirs, a percentage which at the present time has increased to 2.7%, with a total of 28 flood mitigation reservoirs. Within these actions can be emphasized the Flood Protection Plans of the Rivers Segura and Jucar, in the Mediterranean basins. The Plan of the River Segura presents a global concept of the basin and has as its principal aim the protection against the floods of 50 years return period, with 13 flood mitigation dams and an investment of about 500 M$. The Plan of the River Jucar has as its principal objective to avoid the flooding of townships for the flood of 500 years, and for this it has three reservoirs with a more seasonal function of mitigation of damages. The inversion to date has been of some 400 M$.

Finally it can be pointed out that the previsions for the future are those contemplated in the National Hydrological Plan, actually in the phase of analysis and discussion, which with an horizon of 20 years, contemplates the carrying out of 117 Flood Mitigation Plans, of which 12 are Plans with Flood Mitigation Dams with some 40 new dams. It can be observed that the greater part of Flood Mitigation Dams are located in the Mediterranean basins.

THE REDUCTION OF THE HYDRAULIC RISK OF THE TRIBUTARIES IN THE ARNO BASIN PLAN

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This intervention concerns the contribution made by the Hydraulic Institute of Pisa, which is now a Department, to the formation of the Plan for the Arno Basin concerning hydraulic risks. In particular, we dealt with the many Arno tributaries, excluding those whose basin surface was under 100 km^2.

This leaves us with, from upriver, the Solano, Corsalone, Chiana Canal, Ambra, Sieve, Greve, Bisenzio, Ombrone, Pesa, Elsa, Egola and Era (fig. 1). In the table 1 we present, for the tributaries, the catchments areas S, the surfaces and the volumes of the laminated flood control tanks and the reservoirs foreseen. Moreover we present the volumes of the laminated flood relevant of the flood of November 1966 and finally, the attenuation of the maximum discharge ΔQ, for every tributary for the discharge of plan and for the discharge of November 1966. From table 1, results that the total catchment area for the tributaries is 5617 km^2.

Furthermore, there is the Pesica stream which currently pours into the Padule di Fucecchio and through the Usciana Channel, when the Arno is in flood, pours directly into the Arno deviation channel, so it may be said currently the Padule di Fucecchio Basin does not contribute to the Arno floods.

Since, for the most part, hill basins are involved, the foreseen interventions consist exclusively in laminated flood control tanks; that are, planned in areas alredy subject to flooding. The problem, therefore, would be providing for these areas in order to have controlled flooding in order to limit possible damage. Only one deviation channel has been foreseen, in alternative to other interventions, concerning the Era stream, a deviation channel which from just before Pontedera would pour directly into the Arno deviation channel. Plans have been made for reservoirs on the Corsalone, Ambra, Sieve and Pesa streams.

Now the Arno Basin covers 8228 km^2, but if we detract the Padule di Fucecchio Basin, which no longer contributes to the Arno floods, as we saw earlier, the total Arno Basin is reduced to 7742 km^2.

Therefore, the surface of 5617 km^2 represents 72.5% of the entire surface of the Arno Basin.

Clearly, these planned tributary interventions also have considerable influence of the mitigation of the attenuation of the floods of the main branch of the Arno itself.

The overall surfaces of the flood control tanks which have been planned are equal to 75.38 km^2. The tanks have a volume of 138.46 Mm^3, comparable to the volume of the one planned on the main branch of the Arno that is about 150 Mm^3. In the first planned solution in addition to these 138.46 Mm^3 of flood control tanks, there are 4 Mm^3 of the reservoirs, for total of 142.46 Mm^3. Instead of the second solution, we have 128.12 Mm^3 of tanks and 38 Mm^3 of the reservoirs, for a total of 166.12 Mm^3.

From table 1, results that the attenuation of the maximum discharge ΔQ for the plan discharge is strong for the all tributaries (for example, the Corsalone stream from 426 to 290 m^3/s in the solution with laminates flood control tanks and from 426 to 100 m^3/s in te solution with reservoir).

Naturally, this reduction of the maximum discharge is consistent even if we refer to the flood of November 1966. There were some of these tributaries (Solano, corsalone, Ambra, Sieve, and Ombrone) which were practically at their highest level of the preceding two centuries, while there were other (such as the Chiana Canal, Greve, Bisenzio, Pesa, Elsa, Egola, and Era) whose peak discharge of 1966 were high but not exceptionally so.

So if we evaluate the effect on the main branch of the Arno, we see that with the first solution proposed, the overall amount of 142.46 Mm^3 down to 110.06 Mm^3 for the flood of 1966. With the second solution, in the hypothesis of the 1966 flood, would invade about 132.41 Mm^3, as opposed to an overall volume of 166.12 Mm3 (tab. 1). Then farther down, on the other hand, there are the same volumes applied to the situations upriver from Florence. In this direction, the volumes are obviously lower because the tributaries ewamined there are only the Solano, Corsalone, Chiana Canal, Ambra and Sieve.

Therefore, upriver from Florence, in the case of the first solution, we would have 31.32 Mm^3 of overall volume, but in those four tributaries with a lamination effect referred to the 1966 flood, about 21.54 Mm^3. With the second solution, we would have 49.48 Mm^3 on alla four of the tributaries in question, which would drop, in the case of an event similar to that of 1966, to 38.70 Mm^3.

Last of all, consideration was given to the Pescia stream, an outlet of the Padule di Fucecchio, which no longer contributes to the Arno floods, and to the tora stream, which currently pours into the Arno drain channel, and therefore is under the administration of the Arno basin but is not within its hydrographic limits.

Table 1

	Catchment (*S*) [Km^2]	Tanks (*S*) [Km^2]	Tanks (*V*) [× $106m^3$]	1966 (*V*) [× $106m^3$]	ΔQ [m^3/s]	ΔQ (1966) [m^3/s]
Corsalone	88.7	1.01	V_T = 1.5 V_R = 6.0	V_T = 1.5 V_R = 6.0	426-290 426-100	503-340 (Tanks) 503-130 (Res.)
Solano	111.0	0.70	0.98	0.98	486-380	470-380
C. Chiana	1368.0	6.81	10.90	1.13	743-400	327-260
Ambra	204.2	2.62	4.47 Tanks+ 4.0 Res.	8.46	789-370	
Sieve	840.4	5.5	V_T = 9.47 8.13 (V_T) + 15 (V_R)	9.47 23.13	1142-834 (T) 1142-550 (T + R)	1142-834 (T) 1142-550 (T + R)
Greve	284.0	2.52	4.03	2.852	680-510	505-380
Bisenzio	320.8	9.31	25.34	18.62	679-185	570-185
Ombrone	489.1	7.60	15.2	15.2	782-270	805-285
Pesa	339.5	4.68	V_T = 7.5 V_R = 13.0	V_T = 5.8 V_R = 10.0	740-435 740-235	
Elsa	867.0	13.54	24.385	13.54	838-390	700-325
Egola	112.6	0.97	2.5	1.5	479-290	
Era	591.5	20.12	32.19	22.45	798-338	566-240
	5617.0	75.38	138.46	110.06		

first solution: 138.46 (V_T) + 4 (V_R) = 142.46 → ΔV (1966) = 110.06
second solution: 128.12 (V_T) + 38 (V_R) = 166.12 → ΔV (1966) = 132.41

Upriver from Florance

first solution: 27.32 (V_T) + 4 (V_R) = 31.32 → ΔV (1966) = 21.54
second solution: 24.48 (V_T) + 25 (V_R) = 49.48 → ΔV (1966) = 38.70

	Catchment (*S*)	Tanks (*S*)	Tanks (*V*)	1966 (*V*)
Pescia	98		V_T = 3 V_R = 2.3	1.8
Tora	93.4	1.18	1.8	

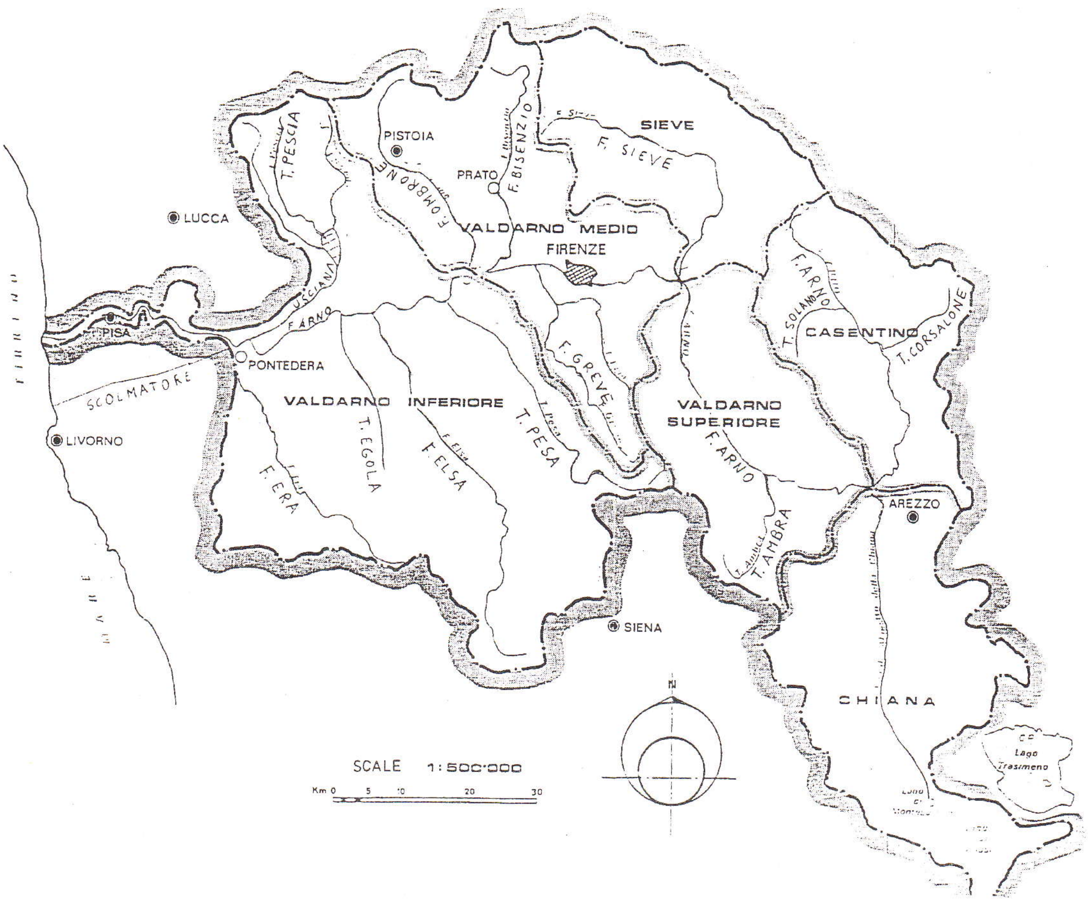
SIEVE
F. SIEVE
PISTOIA
PRATO
F. BISENZIO
F. OMBRONE
T. PESCIA
LUCCA
VALDARNO MEDIO
FIRENZE
F. ARNO
T. SOLANO
T. CORSALONE
CASENTINO
PISA
PONTEDERA
SCOLMATORE
F. GREVE
VALDARNO INFERIORE
T. EGOLA
F. ELSA
T. PESA
F. ERA
LIVORNO
VALDARNO SUPERIORE
T. AMBRA
AREZZO
SIENA
CHIANA
Lago Trasimeno
SCALE 1:500.000
Km 0 5 10 20 30

Fig. 1

Maurizio Mancianti[1]

Amministratore Delegato SOGESID, Roma

As a starting point for operative lines of general interest, I wish to share with you some brief considerations from my experience in the realisation of the Bilancino Dam and the analyses carried out at SOGESID, with reference to the large water systems in Southern Italy.

There is no doubt as to the great importance of the Bilancino dam, which has already been clearly illustrated. Its effects on the lamination of floods along the Sieve, and therefore the Arno, are extremely important, though they have not fully solved the problem regarding the protection of Florence and of the downstream sector from the flow of the Arno.

Concerning the effects of floods control, through an examination of 16 years' records of the Sieve River at Bilancino, it has been possible to evaluate the importance and frequency of the floods in the dammed section. Theoretically, the effect of lamination on the major flood events is about 40% as compared to the natural statistics shown in absence of lamination. Practically the efficacy of the reservoir is thus considerable.

In fact, the most frequent floods occur when the lake is not completely full and the event is almost totally controlled.

For instance, on 4 November 1966, the day of the famous flood, about 20 million cubic meters of water flowed through Bilancino, with a maximum highest point of 546 cubic meters per second. In the hypothesis that the lake had been full, the maximum out flow would have been 330 cubic meters, with a delayed discharge over a certain length of time. Actually, since the level of the lake on 1 November 1966, proved from simulation would have been 6 meters below max quota, the incoming flow in the following days would not have been sufficient to finish filling the lake, and the out flow would have been inexistent.

The first benefit from the presence of the lake would have been felt on the coastal territory of the Sieve, which would not have immediately been overcome by the outgoing water, contrary to what actually came about: especially Saginale, Borgo S. Lorenzo, etc.

The influence would any way have been felt downstream, both for the absence of about one-fourth of the downflow poured into the Arno, as well as for the attenuation of the flood due to the absence of the input from the basin subtended to Bilancino. But besides this, there are other important contributions of Bilancino on drinking water supply for the Florentine area, both in terms of the quantitative effects and qualitative ones, on the recreational-environmental usage along the Sieve and in the central portion of the Arno.

One cannot help but be amazed, however, in examining the total costs of the dam to date, keeping in mind the immobilisation of the expenses borne starting from the first financing in the 80's, with unfortunately no benefits until the present time. We hope to have them any day.

I doubt that the displayed analyses of ex-port profit, considering the fact that the project is not yet working, properly carried out might lead to positive evaluations, considering the expanded costs, independently from extraordinary happenings that ended happily and from the times of realisation.

The case of most of the reservoirs still incomplete in Southern Italy, which by now require new orientation to their purposes, due to the extremely long time which has passed since their initial conception, leads to still more depressing conclusions.

Through hindsight, it must be generally understood that the complex route of conception, planning, building, start-up, operation and maintenance of big works such as dams, especially large ones, requires many accurate verifications and evaluations before starting the project and while it is being carried out; feasibility under technical, economical, financial, legal, institutional, administrative, point of view effects analisys techniques, such as cost-benefit, environmental impact evaluation; operational control techniques, such as project management. All these must be an integral part of every phase of the procedure and not merely occasional. It is thus necessary to make arrangements for specific structures and organisms (it is not enough to encharge someone with the responsibility for the procedure). In this way, it is possible to foresee, verify and manage all the various problems which may arise in the life of the project, using, to this

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end, every instrument possible, such as instruments for preventive, obligatory or subjective agreements, such as services conferences, but also the more recent negotiated planning procedures planning arrangements and agreements, etc.

Last but not least, contract procedures with suppliers must also perhaps be changed, in order to have conditions that are less risky for all.

It seems paradoxical, but the most rigorous traditional forms of contracting have proven to be the least efficient. On the contrary, collaborational arrangements between customers and suppliers may be very efficient and effective if well-managed. It is therefore a question of an in-depth revision of the management of the transaction, or rather the relative system of relationships.

I insist on the fairness of the initial feasibility of the project: a good feasibility can eliminate most of the causes of failure from the start.

Too much time has been spent on the quality of the technical project, not giving enough consideration to the desired effects to the involved subjects,with the result of running often into work sospension, into further mitigation work of environmental and productive impacts, that end up by nullifying the expected benefits.

This is generally true in Italy, perhaps also in the case of Bilancino, and it is thus worthwhile to remember that, if you don't out down the risks of failure associated with the decision to build a big dam it will be necessary to give up the hypothesis of the dam and find different answers to our purposes. I do not wish to be misunderstood here. I am not against big works and big dams, but I believe that in these cases, once the estimate has been made, it is also necessary to imagine different solutions, such as, for example, improving the already existent water plants, especially in order to anticipatedly avoid the necessity of regiming them.

The most difficult and delicate side of the question to be dealt with may have surprising and highly efficient solutions in store, most of which are connected with limiting waste and handing consumption out rationally in the time.

Most of the dams planned or built in Southern Italy for the purpose of supplying drinking water would prove unnecessary with a systematic program of distribution network maintenance, and loss recuperation, which absorbs over 40% of the availability.

But this is also true for irrigation usage, where there is a widespread state of disorganization, from the initial distribution to the final consumer. Here there are often cases of waste at the beginning of the season, regularly followed by shortage when the demand is greatest.

These situations are no longer restricted to the South, but have become commonplace also in the Central part of the country and in the Northern area of Pianura Padana.

Yet these situations could be faced and overcome with non-infrastructural measures and relatively modest costs and timing, through use of long-distance surveys, automation, forecasting models, simulation, optimisation of cultivation cycles, and information campaigns to the benefit of users.

With these brief premises, I conclude suggesting, insofar as it is possible, some lines of action.

Of course, the work necessary to the operation of the dams and water regulation now under way must be completed as quickly as possible. The State and Regional administrations must reach the necessary agreements in order for necessary investments to be quickly resumed and concluded.

Efficient organisations must be established with the active task of completing the dams construction under and the new ones that have been determined to be necessary. Should these organisations already exist, they must be identified and properly managed.

Above all, the maintenance of the existent infrastructural patrimony must be resumed. Every new proposal of larger hydric infrastructure must now be made with a proposed alternative of improvements on already existing ones.

Detailed governmental actions must be enacted systematically, in order to effectively make uses of ground optimised for hydric regulation. These must be able to be covered by public financing and in harmony with the demands of the productive world.

All these lines can be followed and carried out. For this to be possible, however, the main instututional parties involved must unite in their efforts to do so. That means the State with its several Ministries – Public Works, Environment, Finance, Agricultural Resources, the Basin Authorities and the other structural organisations of the central administration, local authorities, but especially the Regions, whose main task is that of local government.

All this begins with the local territory and a transition, that first of all involved a cultural transition, to consider the territory not as a container for disjointed actions, but rather an active system to be governed, and which may prove to be on the right route for decision-making where water and especially major regulation works are involved.

CONCLUSIONS[1]

FRANCO BARBERI

Sottosegretario di Stato delegato alla Protezione Civile

Well, if there are no intervention, I then move to the conclusion of the session and I should try to make some final remarks.

It seems to me that we have had a series of presentation which allow an evaluation of the overall program affecting the Arno River. I think that the better thing is to start with recalling some figure that illustrate the problem.

We have heard that we have in the Arno River a surface at risk of about 1200 square kilometers. In this risky surface leave about one million of person. In the last seven year there were floods not very relevant, not major floods, but that a series of flood that have cost about one billion of US dollars of damages. The biggest of these recent floods was in 1992. And we have heard that the frequency of occurrence of this kind like the 1992 is on average one every 7 or 8 years, so very high frequency.

I think we were all impressed seeing the slides, waiting that changes occurred during the time along the Arno River, and mostly in the last 30 years after the 1966 flood. We know now that should a flood like the 1966 one at the present time, this will cause a damage that can be estimated of about 17 billions of US dollars. On the other hand we have heard of a general strategy to reduce the risk. We have heard that the cost of the overall plan for mitigating the vulnerability for floods on the Arno River is estimated to cost about three thousand five hundred billions of Italian lire, which is roughly two billions of US dollars in the next 15 years. This could appear as a relevant quantity of money, but if we compare damage that is expected in case of repetition of the 1966 event, it is something like one tenth of the overall benefits. The estimation and the analysis – hydraulic analysis on the benefits, that could be obtained by the carrying out of the entire intervention included in the plan, indicated that the risk can be reduced by about 80%. So it will not be 0, but a substantial risk reduction can be obtained by the completion of all the different kind of risk reduction foreseen. And 80% of reduction certainly would be a very relevant, important objective to be achieved.

In a country like Italy, in the presence of such data, the conclusion should be immediate: Central government, Tuscany Region together should find without any hesitation the two billion dollars resource needed to complete this plan. But we have to say that unfortunately, in addition to Arno River, we have very many river in Italy which more or less have the same situation. In all Italian territory, hydraulic risk has dramatically increased anywhere in the last 30 years. And if we compare the events that have affected our land in the last, let's say, in the last 70 years, we have had more than 5000 flood events in Italy. So the same problem are distributed from the Alps to Sicily, anywhere we have this difficulty. So the quantity of money that is requested in order to carry out a systematic prevention plan is an enormous quantity of money. But nevertheless this is a major priority.

That it would be of no use the investment of such a large quantity, if in the same time we are not able as a system, as a social political system, to stop the irrational use that has been made during the years of our territory. We have heard here that only two years ago, the first prevention measure that "prohibit to build more settlements in the highest risk area of Arno River", has been adopted only two years ago, and this measure concerns only one-fifth of the surface that should be included in the prohibition of any further development. This means that, even now, in spite of these data, in spite of the dramatic frequency of the occurence of floods, damages, victims, our system has not yet found the energy, the strength, the capability of imposing rational use of land against private interest, and this is the strongest limitation for any rational action in the future. Any time there is a flood, there is a protest against a Public State that is uncapable of governing the territory, but any time that you try to start a prevention policy, then all citizens, directly affected by the limitation, start to protest.

And so we have a long route to convince, and these are also cultural problems but nevertheless who has the responsibility of governing must be very strong and we have to say these things very strongly.

I think that something is changed in the policy carried out in our country, both at a national and regional level, so these problems at once are now at the general attention. But because of the large

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dimension of the problem, several years are necessary. Fifteen years are estimated to be carry out, the entire plan. This means that, inconjunction with the adoption and the carrying out of the plan, we have to do also very many action, and some has been described here, in order to face the expected flood before the entire plan will be carried out. We also have heard here which is the strategy and which is the way that we have to entirely go on in order to face more conveniently floods. I have to say that some substantial progress has been made in this field in the very last few years. We have increased our capability of meteorological prediction of extreme events. We do not have as yet a very precise, reliable prediction model, but substantial progress has been made and we have some model that, with some confidence, suggest when a dangerous event is going to happen, is impending.

We have heard, in the presentation here, that the monitoring system on all the Arno Basin has been improved, is on the way to being further improved. This starts from meteorological radar to rain meter and all the telemetric sensor that are needed in order to check this situation. The simulation and the definition of a scenario of the expected advance has been established. Through this model, we know that since the moment in which relevant rainfall will start in the Arno Basin, we will have now, before any planned intervention, about six hour before a major flood wave will affect the city of Florence. A series of complex Civil Protection measures has been planned and also experimented in order to use conveniently this six-hour time from the beginning of rain in the basin until the arrival of the flood waves in the town.

So I can say that if we compare this situation with respect to the one that affected Florence thirty years ago, on one side we have to say that the damage in case of a repetition of a similar natural event will be roughly a hundred times higher than thirty years ago, because the irrational use of the territory has increased the vulnerability and value of the properties that are affected to risk.

Today I am confident to say that if we not avoid damages until the plan has been completed, we should be able to avoid at least the human life losses that occurred at the time, and this is a major duty of Civil Protection. In a flood episode, if the territory is managed along the time in such a criminal way as it was here, it is certainly very difficult to face the emergency and to reduce the risk. A long time and a continuous serious policy must be adopted. But I think that we have the scientific and technological capability of forecasting conveniently what should happen, and the loss of human life, when it occurs, mostly depends on the incapability of the Civil Protection system to protect conveniently the people that live in the risk zone.

So this has been our major objective. We cannot avoid damages, but we can protect life and we have the duty as well of protecting, in cities like Florence, the enormous cultural heritage that is property of the entire world. So we have the duty of protecting works and arts from any destruction.

In these two years that I have the national responsibility of Civil Protection, we are faced in Italy with really dramatic problems. That of floods is one. On the other side we have an earthquake, a sismic hazard which is enormous. The prevention policy has been until now almost inexistent. The only important thing is that at least the scientific and technical community has worked very hardly in order to assess the risk, indicate the strategy for their mitigation, improve the capability of forecasting the events, and now these plans, which are at the attention of the public – at any level, from the population to the political responsible, – are certainly the most correct means in order to start at once a more correct policy that in time, hopefully, will bring our country to have an acceptable level of risk.

I hope that from this session you will have had an idea, on one side, of the dimension of the problem, which is really very serious, – and multiply this by hundred going from us to Sicily – and to the other side I hope you have also had an idea that there is an important effort in order to set up, identify, and carry out the most relevant action for the reduction of this risk.

Thank you.