

Introduction

A few years ago at a conference, a Swiss insurance man displayed the chart in [Figure 1](#). It shows the damages paid, year by year from 1966 to 2000, by the Swiss insurance companies for the damage produced by the forces of nature, 60% of which were from floods. The data refers to the whole Swiss Confederation but those produced in the Ticino Canton by Lake Maggiore floods are 2.5 times higher than the national average. Flooding in this lake is a recurring phenomenon. The last, in October 2000, brought the lake level up to 4 m above the average, causing damages that in Ticino Canton alone amounted to more than 100 million euro. At the peak of the flood the flow into the lake exceeded 380 million cubic meters per day, compared to an 'operational' storage of 420 million cubic meters: as if almost a whole lake was entering into the lake. But the 2000 flood, even if significant, is not an isolated case.

Let us look again at the chart in [Figure 1](#): the most impressive thing is not the spikes of the most recent years but the behavior of the phenomenon as a whole, which seems to proceed with exponential growth. A small part of this growth is maybe due to inflation (they are raw data), but the most part? There are two possible causes. First, urbanization has spread to areas that were once exclusively the domain of the lake. Compare the urban plans for Locarno in 1897 and 2000

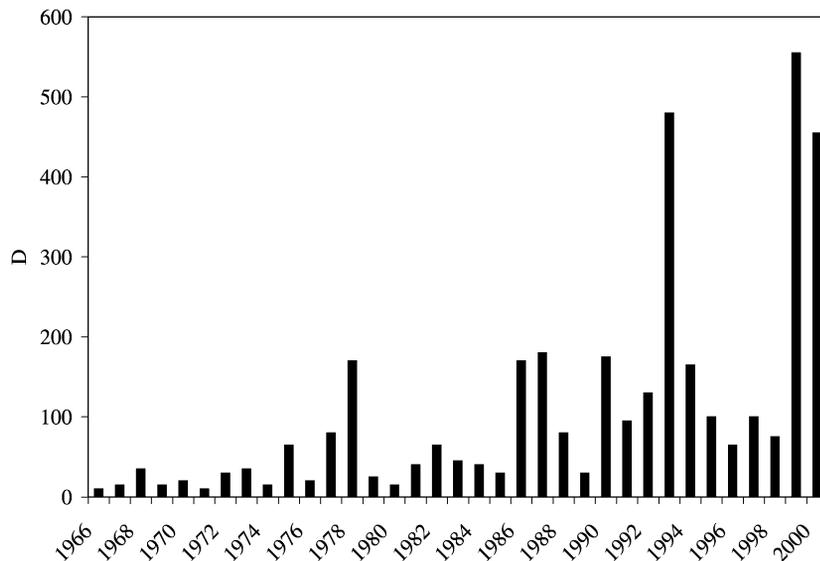


Figure 1: Annual damages paid by Swiss insurance companies for the damage caused by the forces of nature.

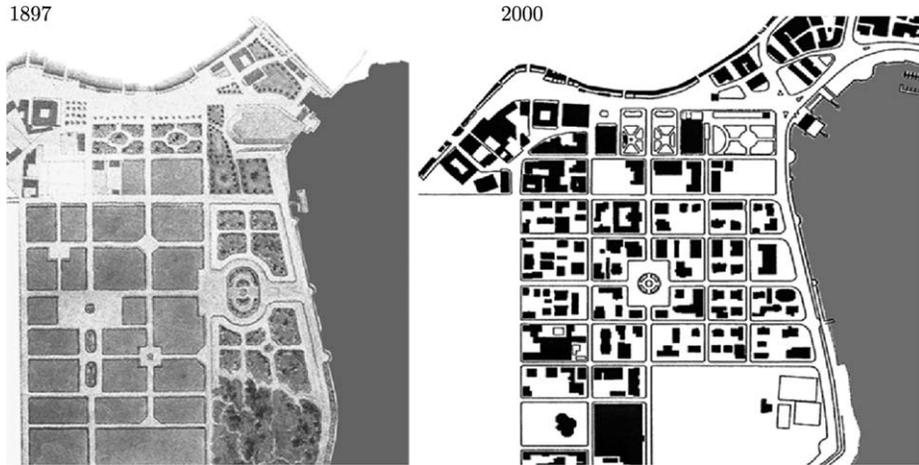


Figure 2: Comparison of two urban plans of Locarno City (by kind permission of the Archivio Comunale di Locarno).

(Figure 2). The urbanization of the areas overlooking the lake is evident: this lake-side city, once able to live in harmony with Verbano,¹ was transformed into a city looking *onto* a lake, as a view just outside the window, hoping that it will remain outside. Second, the apparent worsening of extreme meteorological phenomena, that may be due to climate change.

Facing the problem by acting on these causes would possibly give results only in the long-term, while public opinion asks for quick response. A solution might be to excavate the lake outlet to allow a larger outflow: but the lake outlet is located in Italy, not in Switzerland! So all the Swiss government could do was proposing the excavation to the Italian government. In turn, Italy could not accept the proposal without considering its own interests in the Verbano system: the effluent of Lake Maggiore, the River Ticino, feeds a rich irrigated agricultural activity, producing 45% of Europe's rice, and several hydropower plants; the landscape around the river, a maze of ditches, canals, oxbow lakes, and resurgences, is one of the most interesting anthropic wetland environments in Europe, which has been protected with the creation of two riverine parks; and finally, around the lake itself a rich community has developed, which gets its life and its riches from an articulated and refined tourist industry.

The aim of this book

The search for a solution of the Verbano management problem is the apparent subject of this book. Apparent since it actually is a 'false target': the true aim of the book is to introduce the reader, through a practical approach, to the tools that are available to find solution to problems such as that and to show her/him how the research should be organized in order to create consensus around the solution.

This aim is strategic because the planning and management of water resources are today already key problems, but they will play an even more crucial role in the near future. Just

¹Verbano is the name that the Lake Maggiore side dwellers use to refer to their lake. Since it is the lake's local name and at the same time shorter and more compact than 'Lake Maggiore', we will use it in this book.

as petroleum was a key resource in the XX century, water will be in the XXI. Global water demand has tripled in the last 50 years and it continues to rise every year, since every year the world population grows by 80 million people (Brown, 2001). Seventy percent of the water that is derived from rivers or pumped from aquifers is used for irrigation and, thanks to that, agricultural production provides 40% of the food that we consume. However, demand is increasing, and water availability remains constant in the best cases, when it doesn't actually decrease due to global phenomena, pollution and competition with industry. So the development of methodologies for a more careful use of our precious water capital is a strategic factor for our future. In the last twenty years we have witnessed a flowering of new tools that try to meet this goal.

However, we know well that good tools are not sufficient: it is vital that interventions that are good in name be then actually realized. Many difficulties, however, interfere with the implementation of a project: the main one often being the dissatisfaction of those who were excluded from the benefits provided by the project, or who are, or believe to be, damaged by it. It is essential therefore to be able to evaluate the effects that a given intervention will produce not only on the sector that it has been conceived for, but also on all the sectors that it influences. It is for this reason that in the late 90s a new management paradigm was conceived and began to spread: Integrated Water Resources Management (IWRM) (GWP, 2003).²

Within this paradigm my research group developed a decision-making procedure that is *participatory*³ and *integrated*.⁴ It was called PIP (*Participated and Integrated Planning*) procedure and is presented from the theoretical standpoint in another book: *Integrated and Participatory Water Resources Management: Theory* (in the following referred to as **THEORY**). The present book is aimed at presenting the PIP procedure from a practical point of view, using the Verbano problem as an example and describing in details the actual development of the *Verbano Project*, which was launched in 1999 by the European Union, among the INTERREG-II projects devoted to transnational problems of the EU. Of course, other textbooks exist that give examples of projects for problems of this type, but unfortunately they are often focused only on normative and procedural aspects, or to strategic analysis, omitting all those details that actually are the essence of the project and that make the difference between a successful project and a failure. My ambition for this book is to fill this gap.

Methodological novelties

The PIP procedure contains several interesting methodological novelties. Environmental Impact Assessment and the methodologies of *Multi-Attribute Value Theory* (MAVT) have been employed until now mostly for the assessment of projects concerned with non-dynamical systems (or with systems that are given a non-dynamical description), where only *planning* decisions are considered, i.e. decisions that are made once and for all. This is a strong limitation since most of environmental systems actually are dynamical. For example, Lake Maggiore is dynamical: its state, the lake storage, varies in time and every day a decision

²See also www.gwpforum.org, last visited September 2006.

³Participation is not limited to providing the Stakeholders with information (*Informative Participation*), nor to just asking them for information (*Consultation*), but involves the Stakeholders in the design and evaluation of the alternatives (*Co-designing*) and possibly in the final choice (*Co-deciding*).

⁴In the sense that it considers all the interests in play, independently from their relative relevance.

must be made about the water volume to be released in the next twenty-four hours. Clearly, the release decision must take the available resource into account, namely consider what the lake storage is. Moreover, the decision influences the storage that will result in the following day, thus influencing also the subsequent release decisions: decisions are concatenated and as such they are *management* decisions. Such decisions can be rationally assumed by designing appropriate *management policies*. In the PIP procedure a methodological effort was made to extend the applicability of decision techniques to dynamical system and to the design of management policies.

A second innovative aspect concerns the decision-making procedure. A rich literature exists that deals with the case in which, even in the presence of conflicting interests, the final decision is the duty of a single, high-level decision maker. However, 60% of freshwater in the world is collected in transnational basins, where possible disputes for water use cannot be solved by a supervisor like a government or governmental agency, for the simple fact that such supervisor does not exist. This is the case of Verbano, which extends both in Swiss and Italian territory. In such cases, negotiations are the only possible way to reach an agreement. The PIP procedure was designed by explicitly considering these issues.

Nevertheless, this book is not and is not intended to be a theoretical work. The theory will be referred to only in the measure necessary and sufficient to allow the reader to understand what was done for the Verbano problem and, above all, what should be done in good decision-making practice. It involves issues from four major disciplines: Hydrology, System and Control Theory, Decision Theory, and Information Science. For deeper understanding in the theoretical aspects, the interested reader will find precise references to [THEORY](#).

To whom this book is addressed

The natural users of this work are engineering firms, water agencies and university students.

As for university students, the book can be employed in courses that deal with management and planning of water resource (or with Environmental Impact Assessment) in both Environmental Engineering and Science Faculty, both at under-graduate and post-graduate levels. In first level courses, it could be opportune presenting only procedural and decisional aspects, and thus [Chapters 6–8](#), which deal with modelling and control, might be skipped. Finally, this book can also be used as a source of examples for more theoretical courses that adopt [THEORY](#) as a textbook.

Please note that this book and [THEORY](#) share the same terminology and the same overall structure. Even more: they share [Chapter 1](#) (*Making decisions: a difficult problem*) since, in a sense, the following chapters in the two books are none other than two parallel and alternative ways of developing the content of that first chapter: the theoretical oriented approach and the practically oriented one.

Three levels of reading

Too much attention to detail could easily produce a work that is boring and unreadable. Conscious of this risk, I have structured the book at several levels of reading.

The first, introductory level is supported by a video documentary and by the summary document. The documentary, which was created by Swiss Italian television with my advisory support, gives the reader a live introduction to the Verbano problem and the decision-making procedure adopted for its solution. It serves as both an audiovisual introduction to the entire book, as well as an index, since its captions link to the section of the

book that describes the issues that are being dealt with in the video. The summary document (Chapter 15) is a document that summarizes the development and results of the Project and that is submitted to the final Decision Makers, who needs to catch the essential of the Project results without lingering on technical details. A synthetic document of this type is required by good practice and is helpful to improve participation and communication with the final Decision Makers. Part C of the book begins with this document, which provides the reader lacking time with an overall vision and allows the reader that has followed the work step by step to review the principal phases.

The second level, embodied in the volume that you have in your hands, describes the entire Verbano Project. It describes: the decision-making procedure used in the Project (Chapter 1); the setting of the Project (Part A), from the recognition of the system and the definition of the Project Goal, to the practical definition of the procedure to be used for identifying the most interesting alternatives (called *reasonable alternatives*); the implementation of that procedure and negotiations among Stakeholders (Part B); the summary document, considerations about the final negotiations among the Decision Makers and about the implementation of the best compromise alternative (Part C).

At the third level the description of the Verbano system is further detailed in its social, economic and environmental aspects. The presentation is made by Experts from each sector and enriched by images and videos. All this material is presented in a hypertext format on the DVD attached to the volume.

To facilitate the ‘navigation’ of the work, the text and the DVD share the same index. It is reproduced in both and the lighter shade of the title of a section and the icon  indicate that the corresponding section is physically present only in the other support. The icon , inserted behind a section title printed in the normal shade signifies that additional material on the same topic is contained on the DVD. I hope that in this way we have helped the reader to form a single mental image of the work, even though it is physically based on two different media.

WEB site

To facilitate the updating of this work, a WEB site is available (www.elet.polimi.it/people/soncini) where the reader will find didactic material, updates and the errata–corrigenda prepared on the basis of the comments and suggestions provided by the readers.

Where to begin

I believe that I have set out all of the salient points. Now it is your turn. If you are a hurried reader with some knowledge of the matter, I suggest to begin with Chapter 15, the summary document of the Project: it will provide you with a quick panoramic view and direct links to the chapters that interest you the most. If you have interests in the methodology you can start from Chapter 1, which illustrates the decision-making procedure (PIP) that was developed for the study and that constitutes an annotated index of Part A. Those that have time, can just start from Chapter 1 and proceed with the subsequent chapters, following the phases of the PIP procedure step by step. But if you come from reading THEORY, you may omit Chapter 1, since it is analogous to Chapter 1 of that book. However, everyone is first invited to see the documentary *Verbano, let's get it together!* contained on the DVD (it only takes 30

minutes), the subtitles of which point to the part of the work in which the issues presented are dealt with.

Enjoy your reading!

I would be very grateful for comments or suggestions.

Politecnico di Milano, 10 December 2002

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Post-scriptum of June 2006

Once this work had been completed I prepared myself to create a work with a stronger theoretical scope, which would describe in details the methodological aspects that were developed *ad hoc* in the elaboration of the *Verbano Project*. This is how **THEORY** was born. In the meantime the application of the PIP procedure to other projects both national (*Iseo Project*, *Piave Project*) and international (MERIT Project EU-FP5) demonstrated that it had a much greater value than the one I had perceived at first. This conviction was confirmed by the adoption of PIP as one of the basis of the *Planning Framework* proposed⁵ by the Harmoni-Ca Project (EU-FP6) for the development of the River Basin Management Plans required by the Water Framework Directive (WFD) of the European Union [Directive/2000/60/EC]. The experience gained through Harmoni-Ca shed light on the usefulness of the PIP procedure not only for the drawing up of participatory and integrated River Basin Plans, as required by the WFD, but also to make Plans more comparable.

The text is not systematically framed in the WFD, since it was born before it but the core concepts of the directive were correctly anticipated. For the publication of the English version, I thought about updating it, to make it coherent with the way that these concepts have matured two years after the completion of the first edition, but I felt that the effort would be useless: it would have delayed publication by at least one more year and in the meantime **THEORY** would also have aged. Knowledge advances very quickly these days, especially at the interface between society and technology in the so-called Information-Society, while the time it takes to write a book has not changed for centuries. This is the reason why the reader will not find in this book some ideas that do appear in **THEORY**, which we highly recommend to the interested reader.

⁵See Work Package 3 on <http://www.harmoni-ca.info>, last visited on September 2006.

Acknowledgements

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The work would never have been what it is without the enthusiasm, the passion and the mirth of Alessandro, Emanuele and Francesca, three students from my course that began the work as master theses and finished it once they had already got the master. They did a great amount of work and so their names deservedly appear on the chapters of this book. Nevertheless, without the tenaciousness of Enrico Weber, the computations would never have been completed. He created large part of the computer codes, launched optimizations and simulations for a total of about one hundred full days of computing time, and finally, heroic work, he restored the model's database after the disastrous surprise attack from a hacker in the Christmas vacation of 2001, that caused us enormous damage, especially because the last back up had been mistaken (and who says that Murphy's law is not scientific?!).

Many are the people to whom I am in debt for the help and the collaboration that they offered to us. A special acknowledgement goes to Bruno Bolognino, from the *Associazione Irrigazione Est Sesia* and to Nicola Patocchi, from the *Fondazione Bolle di Magadino*, for their willingness and availability to respond quickly to every one of my questions, even if at times they came at an un-orthodox hour. I am grateful to all of the representatives of the *Stakeholders*: Raffaele Babuscio, Doriana Bellani, Gerolamo Boffino, Lorenzo Del Felice, Andrè Engelhardt, Piero Ferrozzi, Gianfranco Gasparini, Francesco Grecchi, Claudio Peja, Ambrogio Piatti and Cesare Puzzi who actively participated in the negotiations meetings. I am even more grateful to those of them who were willing to enrich the DVD with a description of their sector, in which they encapsulated a great deal of experience. You will find their signatures on the texts that they produced. Thanks go to Andrea Rizzoli, coauthor of the first release of TWOLE, the MODSS used in the Project, who affectionately helped us in making several difficult modifications to it and to Luca Villa who created the first version of TWOLE. Final thanks go to Andrea Castelletti and Mariangela Crocetta who re-read the whole Italian manuscript with patience and care; to Guido Sagramoso who nursed, with his natural perfection, the adaptation of the videos that furnish the DVD, to Giulio Roggiro who designed it friendly interface and solved the problem of reading it with free software tools, and lastly (last just because in every list someone must be the last) to Marco Montanini who spent a great deal of energy to create the architecture and to assemble the DVD.

For the English edition a very, very warm thanks goes to Valerie Cogan for the care and love that she placed in translating and to Jonathan West for his careful, high professional revision of the manuscript.

A completely separate acknowledgement goes, at the very end, to the Swiss-Italian Television (*Televisione della Svizzera Italiana (TSI)*) and to its producer Enrico Pasotti,

who agreed to create the documentary that describes our study and to enrich the DVD with other documentaries produced by them. They courageously opened the road to an activity which I believe will be a joint activity of publishing and television in the future: the creation of interactive video-texts for more incisive teaching.

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Translator's note

In order to avoid boring forms like (s)he and his/her, which are used to acknowledge the fact that both men and women can be found performing all the roles described in this book, we chose to allocate each of our characters with a gender right from the beginning, and have been consistent throughout. Place names and names of institutions are for the most part in Italian. As much as possible we have maintained the original names, while substituting