I TECHNICAL COMMITTEES di ICOLD

Il contributo italiano

Technical Committee «DAM SURVEILLANCE"

Alberto Masera

Dam Surveillance

- **24 Settembre 2003 : Lettera per Richiesta per la adesione e partecipazione al Gruppo di lavoro ICOLD “Committee on Dam Surveillance”**

Committee on Dam Surveillance / Comité de la Surveillance des Barrages
Membership list / Composition (2003-2007-2009)

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Vice Chairman / Vice Président	
Argentina / Argentine	Alejandro PUJOL
Members / Membres	
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Egypt / Égypte (3)	Ashraf EL-ASHAAL (3)
Finland / Finlande	Jussi PYYNY
Former Yug. Rep. of Macedonia / Ex Rép Youg. de Macédoine (2)	Slavko MILEVSKI (2)
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New Zealand / Nouvelle-Zélande	Peter SILVESTER

(1) Member since 2004 / Membre depuis 2004
(2) Member since 2006 / Membre depuis 2006
(3) Member since 2007 / Membre depuis 2007
(x) Corresp. Member 2003-2007 / Membre correspdt 2003-2007 : Jiri POLACEK

Dam Surveillance

2008 – B138 - GENERAL APPROACH TO DAM SAFETY

GENERAL APPROACH TO DAM SURVEILLANCE

INTRODUCTION A LA SURVEILLANCE DES BARRAGES

Bulletin 138

International Commission on Large Dams - *Commission Internationale des Grands Barrages*

CONTENTS

Dam Surveillance

REFERENCE A BOLLETTINI – QUESTIONS

Quelques references ***Some references***

ICOLD **Bulletin 60 (1988)** merging of Bull. **21 (1969)** & **23 (1972)**
Dam monitoring, General considerations

ICOLD **Bulletin 62 (1988)**
Inspection of dams following earthquakes, Guidelines
/ Committee on Seismic Aspects of Dam Design (A. Bozovic)

ICOLD **Bulletin 68 (1989)**
Monitoring of dams and their foundations, State of the Art
Overview (14 p.), and 11 nos. National Reports : *(9 english + 2 biling.)* = 292 p. append.

ICOLD **Bulletin 87 (1992)**
Improvement of existing dam monitoring, Recommendations and case histories
15 pages main text + 75 pages append.: 12 examples, from 7 countries

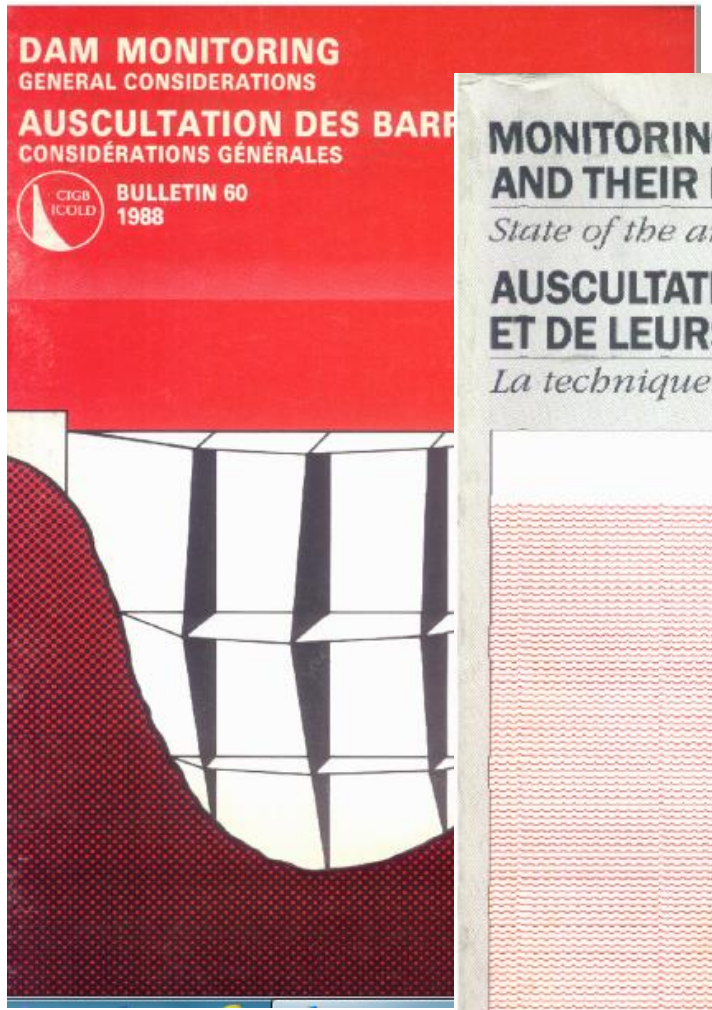
ICOLD **Bulletin 118 (2000)**
Automated Dam Monitoring Systems, Guidelines and case histories
2 x 83 pages (main text bilinguish) + 83 pages annexes (English only)
with 12 case histories from 11 countries

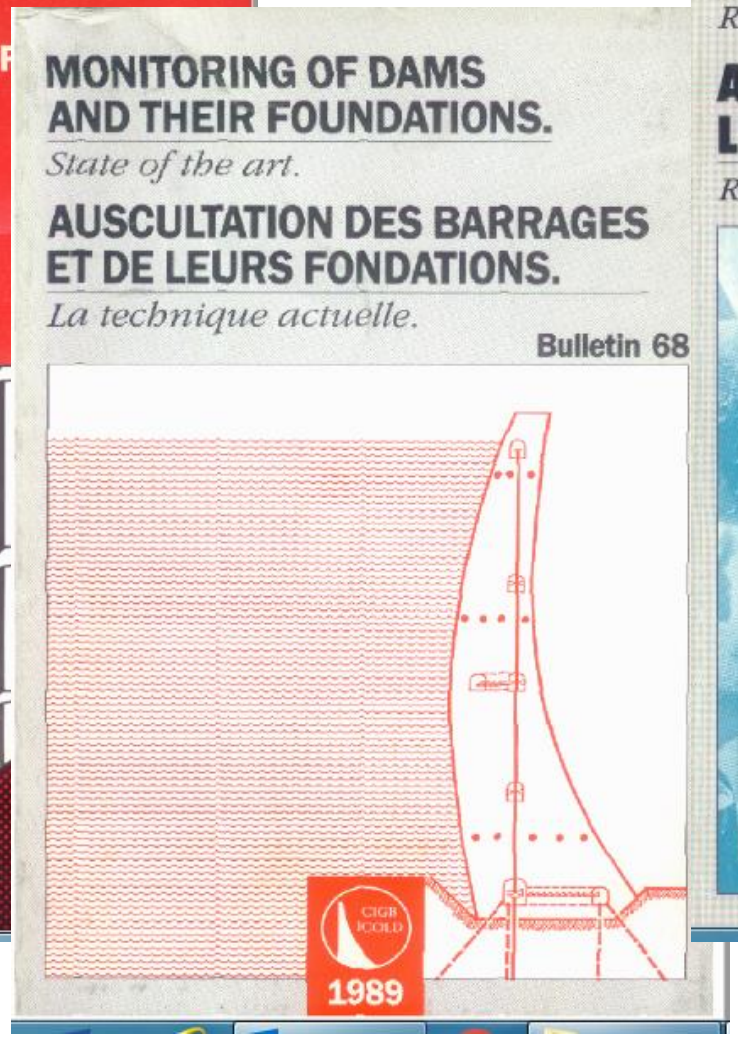
ICOLD **Question 78 (2000)**, Beijing Congress
Monitoring of dams and their foundations / ***Auscultation des barrages et de leurs foundations***
Vol. III: 1545 pages, 85 reports + General Report by Elmo DIBIAGIO, and vol. V: pp. 259-414.

BETCGB (France, **2002**)

Dam Surveillance

REVISIONE DI BOLLETTINI SUL MONITORAGGIO





Dam Surveillance

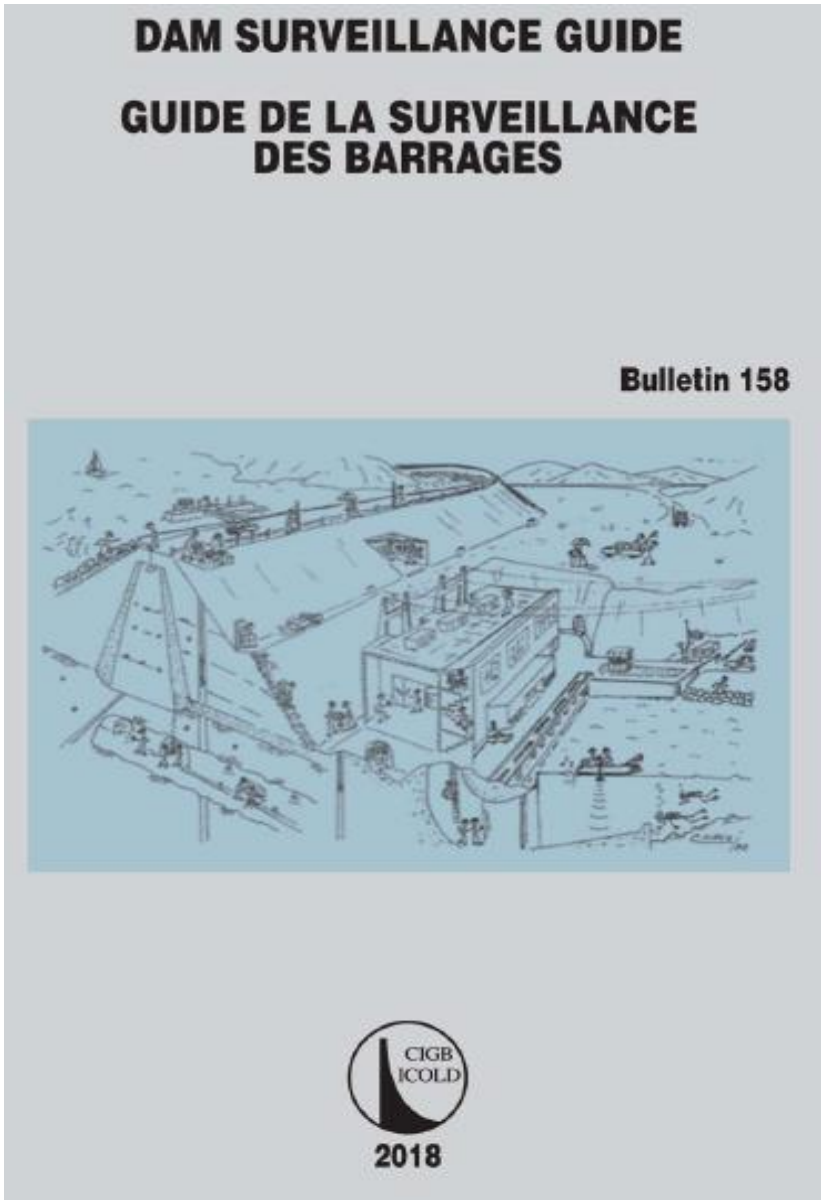
Bulletin 138 (ICOLD: 2009) General Approach to Dam Surveillance

Bulletin 138 provides an optimal organisation of all components required for dam surveillance and monitoring. The contents are more philosophical in nature, so as to accommodate international state-of-the-art. The subject is generally covered in broad terms with references to detail.

Bulletin 158 (ICOLD: 2013 English and 2016 French) Dam surveillance guide

Bulletin 158 is a guide on dam surveillance, more practical in nature than Bulletin 138, accommodating international state-of-the-art. The subject is generally covered in broad terms with references to detail.

Dam Surveillance



2018 – B158 – DAM SURVEILLANCE GUIDE

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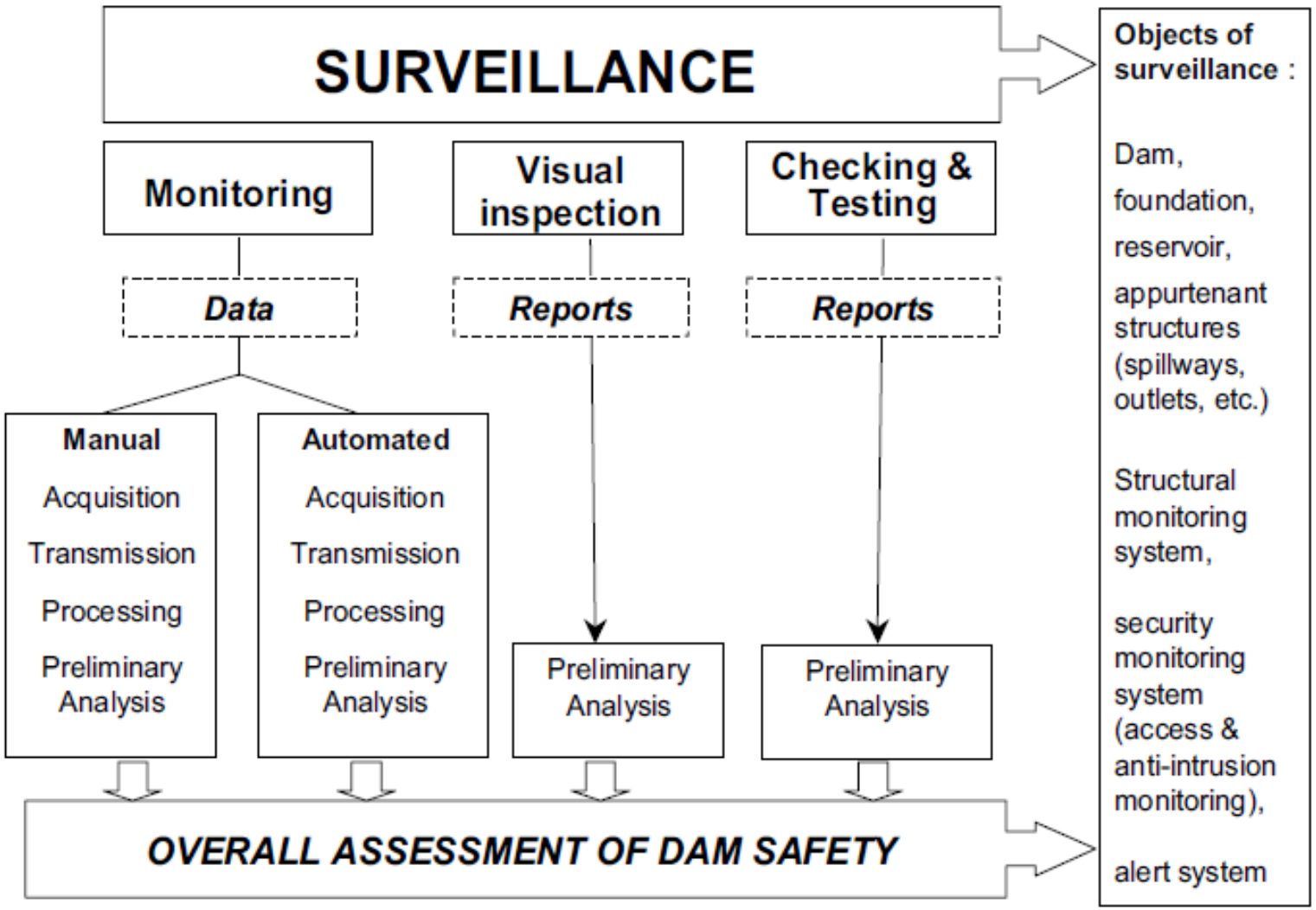

CAPITOLO SULLE MODERNE TECNICHE DI MONITORAGGIO

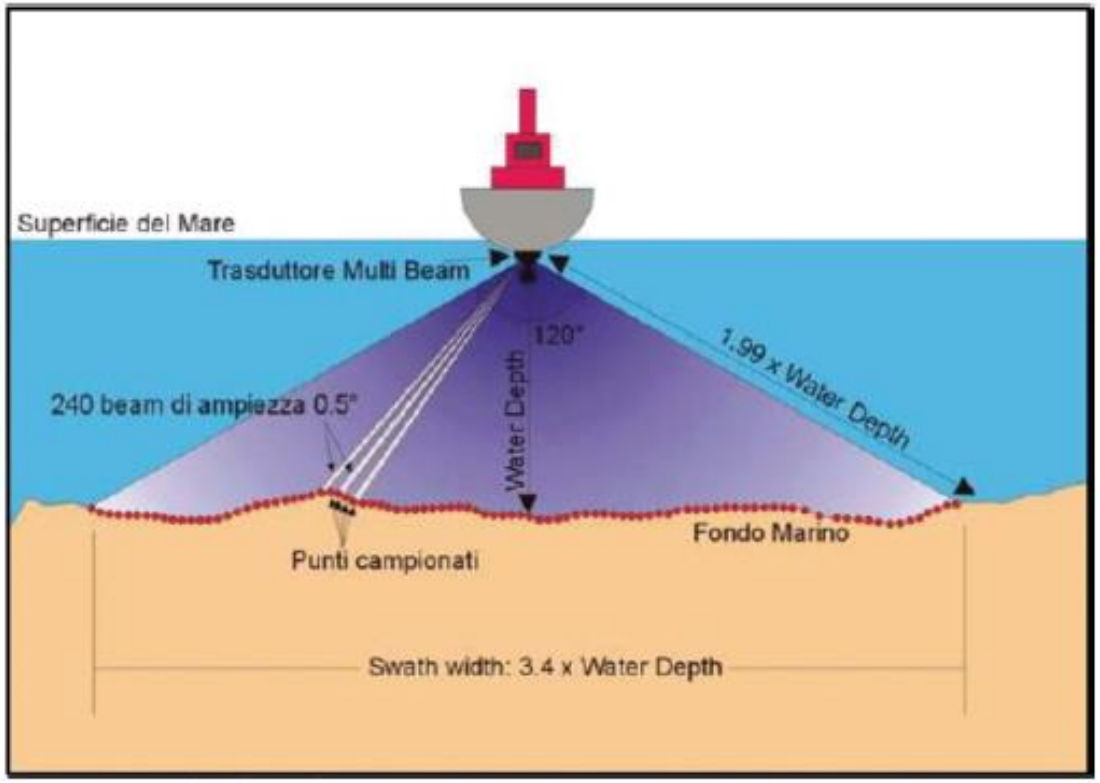

Figure 8.7.1
Multi-beam bathymetry technique

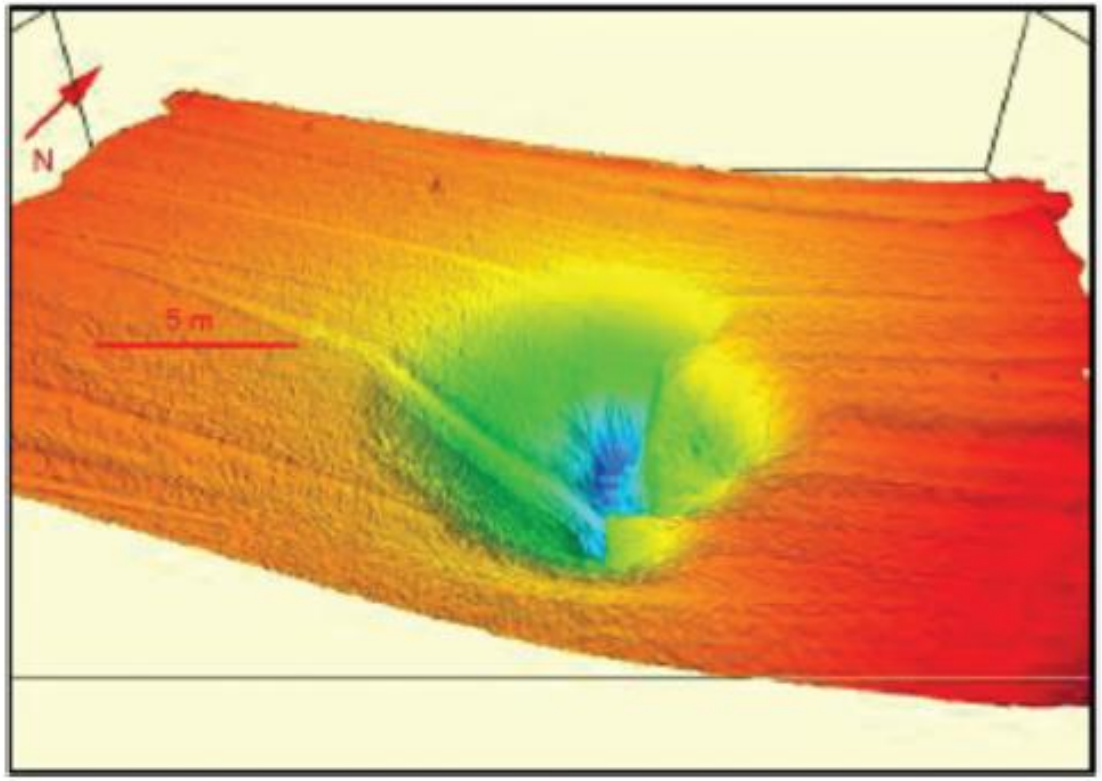

Figure 8.7.2
Three-dimensional vision of a bottom outlet with surrounding sediments

Dam Surveillance

CAPITOLO SULLE MODERNE TECNICHE DI MONITORAGGIO

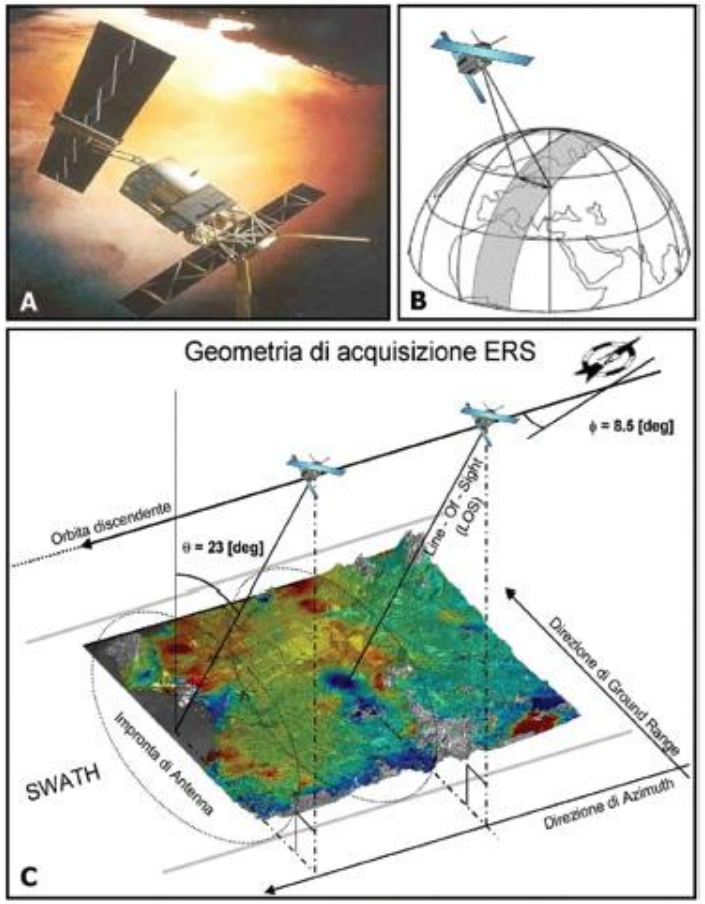

Figure 8.9.1
Acquisition geometry of ERS Satellites

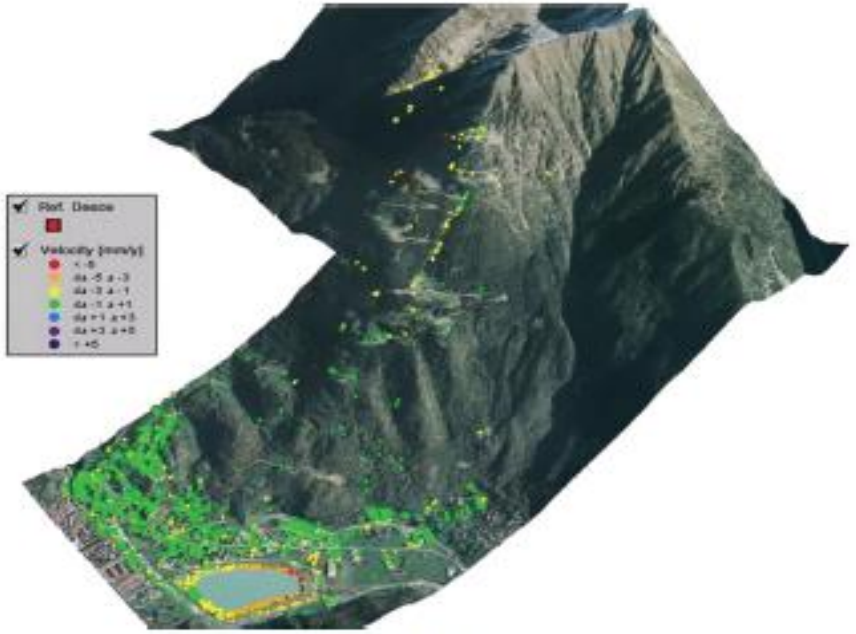

Figure 8.9.2
Représentation des PS (Réflecteurs Permanents) et le Modèle Numérique de Terrain (MNT) avec le bassin de retenue

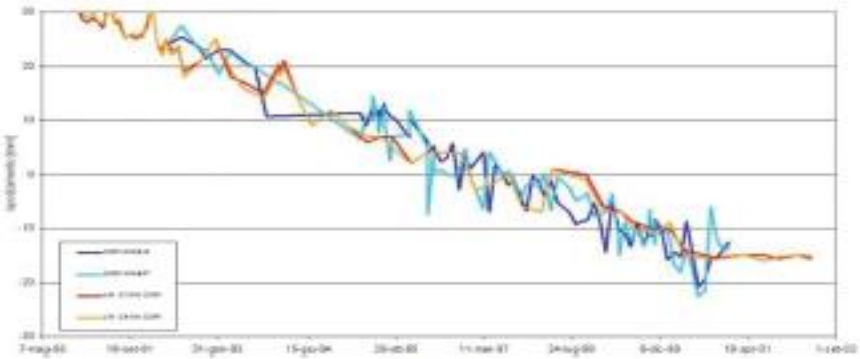

Figure 8.9.3
Comparaison des déplacements verticaux (PS et nivellement de précision) mesurés sur la crête du bassin de retenue présenté dans la Figure 8.9.2

Dam Surveillance

CAPITOLO SULLE MODERNE TECNICHE DI MONITORAGGIO

Figure 8.10.1
Venina Dam from ground SAR station

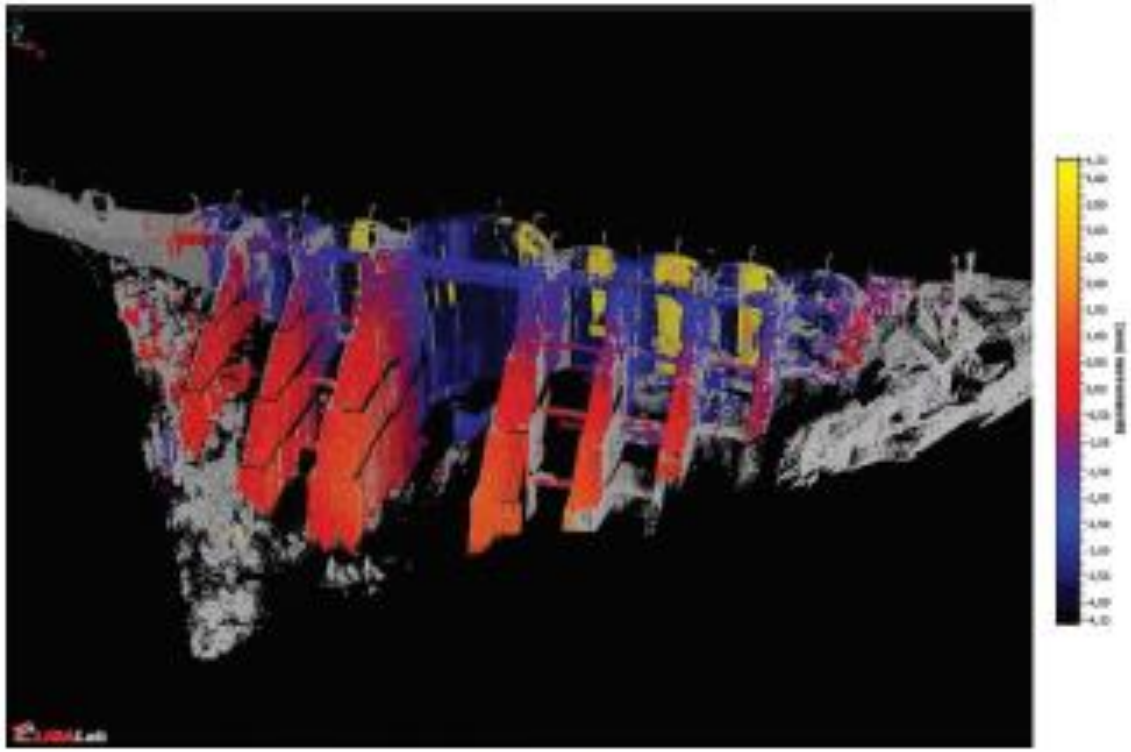

Figure 8.10.2
Barrage de Venina - Cartographie des déplacements (entre août 2006 et décembre 2006). La comparaison des déplacements du barrage mesurés avec la méthode SAR et les mesures de pendules souligne une bonne cohérence et une bonne précision de la méthode correspondant à ± 0.4 mm.

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CAPITOLO SULLA «DATA ANALYSIS»

Dam Surveillance

2017 – B180 – DAM SURVEILLANCE – Lessons learnt from case histories

DAM SURVEILLANCE

LESSONS LEARNT FROM CASE HISTORIES

Bulletin 999

International Commission on Large Dams – Commission Internationale des Grands Barrages

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Dam Surveillance

1.1 Mandate

The Terms of Reference (ToR) of the Technical Committee on Dam Surveillance (TCDS) were approved at the Annual Meeting in Kyoto 2012 for the term 2013-2016. The Terms of Reference (ToR) of the present Dam Surveillance Committee are basically to prepare a series of dedicated dam surveillance bulletins covering:

- *Methods for the improvement of the quality and reliability of information;*
- *Data processing and representation techniques;*
- *Effective Diagnostic analyses to determine behaviour patterns;*
- *Dedicated surveillance systems for the optimization of maintenance-, rehabilitation- and other life cycle costs; and*
- *Impact of surveillance (preventing dam incidents and dam failure by means of selected case histories).*

An informal meeting of previous TCDS members was held in Kyoto, on 4 June 2012. It was decided to start off with a bulletin on dam surveillance case histories. In Stavanger, the term of the TCDS was extended until 2018.

Dam Surveillance

The nine benchmark case histories are the following:

- Malpasset Dam (importance of monitoring engineering geological aspects);
- Vajont Dam (importance of monitoring reservoir slopes);
- Zeuzier Dam (the unbelievable effect of pore pressure relief);
- Teton Dam (value of diligent visual observations);
- Dnieprostroi, Möhne and Eder Dams (explosive loads during World War II);
- Folsom Dam (gate failure, tested regularly but not all the way through);
- Cahora Bassa Dam (the value of diligent installations on the life of instruments);
- Zoeknog Dam (failure, predicted by pore pressure gauges, but ignored); and
- Tous Dam (backup systems failure).

Further to these 9 benchmark case histories, members and observers of the Technical Committee on Dam Surveillance added a total of 71 additional case histories, representing a wide range of practical aspects a surveillance engineer might encounter in his professional activity. Around 80 professional dam engineers have contributed by means of being authors or co-authors to the case histories of this bulletin.

Dam Surveillance

AMBIESTA DAM – CRACKS DETECTION USING SONIC TOMOGRAPHY

Dam type: Arch dam (Dam Height: 58,63 m - Crest Length:144,64 m)
Case history category: e, c, d
Main objective: Detection of cracking patterns inside the dam body
Main benefit: Early detection of cracking patterns variations or extension
Observations:

The investigations have used geophysical techniques such as sonic tomography and micro seismic refraction in the dam wall, with the aim of characterizing the concrete of the area affected by the cracks patterns compared to healthy areas, constituting the dam body, and to trace the penetration depth of the cracks visible from outside face. The sonic investigation has been processed using the modulus of Attenuation of P waves coefficient (MAP).

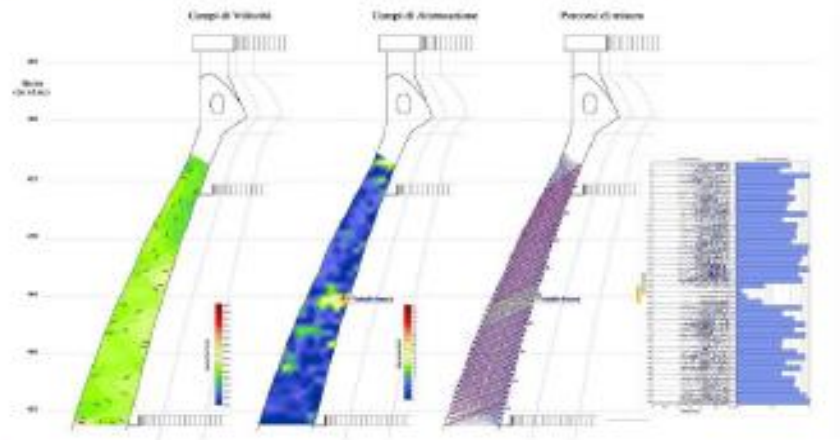

Fig. 1. Ambiesta Dam – Velocity tomography (Left) calculus of MAP (middle) and ray path tracing (Right)

The results of the investigation put in evidence that the cracks appeared planar and sub-horizontal towards upstream-downstream and the cracks are not passing the entire structure. The attenuations of the amplitudes of the individual signal detected have confirmed the presence of the cracks showing a decrease of the energy content of the signals that pass directly through the cracks, but highlighting at the same time as the cracks are not through the entire thickness of the dam.

LESSONS LEARNT

The technologies adopted for the investigation put in evidence the ability to characterize the concrete constituting the dam and define the cracks pattern inside the structure.

ISOLA SERAFINI TRANSVERSE - BATHIMETRY TO PREVENT EROSION

Dam type: Transverse
Case history category: e, c, d
Main objective: Early detection of failure mechanisms
Main benefit: Correct and on time remedial action
Observations: Early detection of potential erosion and assessment of remedial works

The monitoring of downstream bathymetry at Isola Serafini transverse is used in order to prevent erosion and verify the rehabilitation intervention, using multi-beam technique.

Fig. 1. Isola Serafini Transverse

In order to verify the rehabilitation intervention and to prevent erosion, the dam owner uses multibeam bathymetry technique to define the river bed downstream of the dam. Such a survey is performed yearly or in any case after a very big flood.

LESSONS LEARNT

The monitoring of downstream bathymetry at Isola Serafini dam, using multibeam technique, put in evidence the possibility to verify the adequacy of the rehabilitation intervention, to control the downstream erosion and to activate subsidiary solution, if necessary.

Dam Surveillance

MISTRAL SOFTWARE FOR ON-LINE MONITORING SYSTEM

Dam type: Different types
Case history category: f
Main objective: Innovative data processing and presentation techniques
Main benefit: to support decision system for dam safety management
Observations:

The use of a software to support decision system for dam safety management based on automatic monitoring system, theoretical reference models and structural behavior. Such installation allows to obtain on-line evaluation, explanation and interpretation of dam's behaviour, identifying surveillance activities to manage anomalous trends or to minimize critical situations due to flooding or to earthquakes.

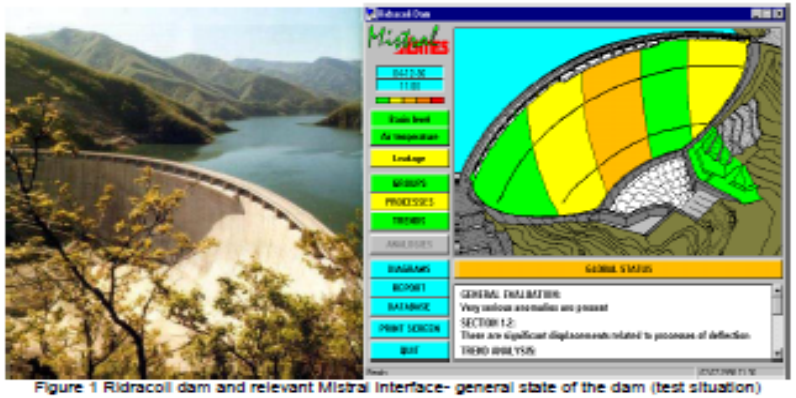

Figure 1 Ridracoli dam and relevant Mistral interface- general state of the dam (test situation)

The measurements recorded on the dam have been processed to analyze the dam's behaviour. The analysis allowed identifying for each instrument a set of thresholds for the measure and for its rate of variation and confidence limits with respect to the value forecasted by the model. The analysis checked also the logical consistency of the information provided by different instruments affected by the same phenomena.

LESSONS LEARNT

MISTRAL is a decision system for evaluating, explaining and filtering the information collected by the most important instruments connected to the automatic monitoring system, providing on-line interpretation of the behaviour of the structure in order to support the activity of the personnel responsible of the safety surveillance. Monitoring and data analysis are primary parts in managing the safety of dams by risk assessment methodology. The on-line data analysis and the surveillance management have become a part of the safety procedures of the dams.

SAN GIACOMO DAM – MONITORING OF UPLIFT PRESSURE

Dam type: Buttress (Dam Height: 97,5 m - Crest Length:971 m)
Case history category: e, c, d
Main objective: Stability Analysis
Main benefit: Uplift force to verify sliding condition of the structure
Observations:

The monitoring of uplift pressure at San Giacomo dam allowed to determine the "real" uplift force and consequently verified that the structure is in a safety condition with respect to the sliding condition

Fig. 1. San Giacomo Dam

Automatic piezometers were installed to monitor water pressure in the foundation and evaluate the uplift forces at the base of the dam. The piezometer measurements showed that the pore pressure was quite homogenous along the longitudinal profile of the foundation surface. The data collected confirmed the stability of the behavior on time.

The benefits attributed directly to the monitoring program is that the data collected gave the possibility to evaluate the actual global uplift forces acting on the buttresses in comparison to the conventional uplift forces prescribed by Italian Regulation. The measured uplift force confirmed the positive actual safety ratio with respect to stability analysis.

LESSONS LEARNT

The monitoring of uplift pressure at San Giacomo dam allows to determine the "real" uplift force and consequently verify the safety ratio of the structure with respect to static load for sliding condition.

Dam Surveillance

- **Bollettino «DAM SURVEILLANCE – Lessons learnt from case histories» – possibili aggiornamenti e organizzazione di un Osservatorio (creazione di una data base)**

- **Nuovo Bollettino finalizzato «Acquisition and interpretation of surveillance data and observations»**
- **Main aspects:**
  - **Methods for improvement of the quality and reliability of data/information**
  - **Data processing and representation techniques**
  - **Effective diagnostic to determine behavior patterns**

- **Estensione delle attività del Comitato al 2023**

Dam Surveillance

SEGNALAZIONE

June 15th

COURSE TOPIC	TIME (CET)	SPEAKER
Opening of virtual booth and participation access 09:00-14:00		
The importance of geotechnical and structural monitoring for railway assets management	14:00-14:30	Andrea Pigorini & Andrea Nardinocchi
Landslide monitoring along transportation networks	14:30-15:00	Jean Hutchinson
Break 15:00-15:30		
Case Histories and Lessons Learned	15:30-17:30	**Moderator: Giorgio Pezzetti**
• Dam surveillance: A look back into the past and the way forward		Louis Hattingh & Manuel Gomez de Membrillera Ortuño

GRAZIE PER L'ATTENZIONE

Titolo